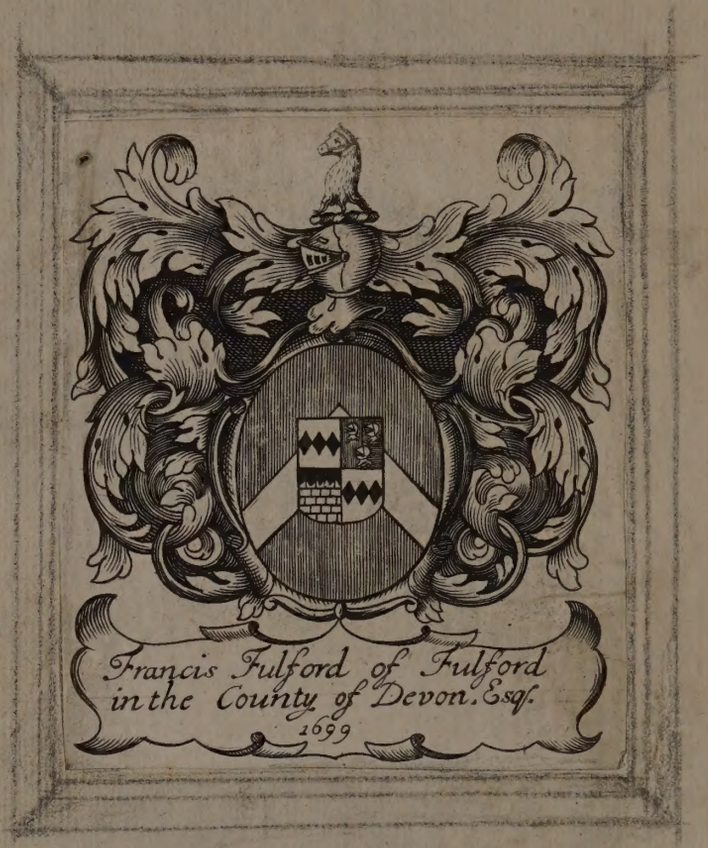
FATIO DE DUILLIER, N.



By Fatio de Duillier, N.

Catalogued 14/11/35


S. Gribelin inv. et sculpsit

FRUIT-WALLS IMPROVED,

By Inclining them

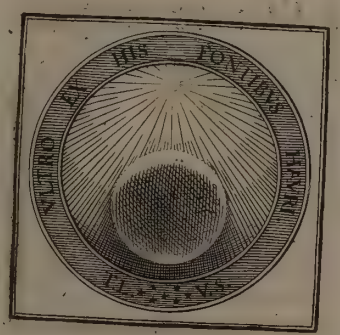
TO THE HORIZON:

OR, A WAY

TO BUILD WALLS FOR FRUIT-TREES;

Whereby they may receive more Sun Shine, and Heat, than ordinary.

By a Member of the Royal Society.



LONDON:

Printed by *R. Everingham*; and are to be sold by *John Taylor*, at the Sign of the *Ship*, in St. *Paul's Church-Yard.* MDCXCIX.

Imprimatur

Liber cui Titulus, *Fruit-Walls Improved, by inclining them to the Horizon.*

John Hoskyns, *V. P. R. S.*

August 31.
1698.

TO THE
RIGHT HONOURABLE
THE
MARQUISS OF TAVISTOCK.

MY LORD,

WHile Your Lordſhip fits Your Self, in Your Travels, to follow the a Foot-

Footſteps of ſo many glorious Anceſtors, I prepare for You, in the Culture of Fruits, a Diverſion to thoſe great Occupations, which Your Birth will hereafter bring upon Your Lordſhip. I was walking with Your Lordſhip, when I firſt thought of this Way, to make our Gardens yield better Fruits. Beſides, My Lord, I cannot forget what other Titles you have, to look upon this as a domeſtick Production.

I ſhall think my ſelf happy, if I can add ſomething to the Innocent Pleaſures of many Nations; eſpecially this; for which, as well as moſt of the Neighbouring Countries, what I have to propoſe ſeems to be of moſt Uſe.

However, My Lord, I ſhall be ſatisfied, if, by thus indeavouring to become uſeful to Your Lordſhip, I expreſs my moſt ſincere Gratitude, for all the Obli-

gations I have to Your Illuſtrious Family.

I am with all manner of Reſpect,

My Lord,

Your Lordſhip's

Moſt humble, moſt obedient,

and moſt obliged Servant,

N. F. D.

The PREFACE.

THE Reader may, perhaps, think it ſtrange to find, in this Diſcourſe, a mixture of Gardening and Geometry; theſe having had hitherto but little communication with each other. But ſuch is the wonderful extent of Mathematicks, that very few Arts can be named, but what may be, by a due Application of them, in a great meaſure improved. At leaſt I hope Experience will make this plain, in the very caſe we have under conſideration.

I might have publiſhed only that part of this Diſcourſe, which could be underſtood by every body; or elſe have placed the Mathematical part, wholy by it ſelf. But it was hard to ſeparate them, without an injury to both. And I thought it better, that whoever dos not care, for what relates to Geometry, ſhould be deſired, from hence, to read only what the Table, or Margin, will ſhew him to be moſt for his uſe.

And, leſt the niceſt Reader ſhould have yet any occaſion to complain, and think it too great a trouble, for him to chuſe what

he

he may read, and what he may paſs over, I have all along ſet, in the Margin, ſome Commas, over againſt ſuch places, as any one, not skilled in the Mathematicks, may freely avoid. I muſt however except the two or three firſt Sheets, which were already Printed, before I thought of this Diſtinction. The remaining Diſcourſe, tho ſome few Words in it may not be underſtood, by ſuch as are unacquainted with the common Terms of ordinary Arts, will, I hope, neither prove tedious, nor offenſive, to any Lovers, of Gardening; even Ladies themſelves not excepted. Where I

have

have used a double row of Commas, I desire to have no other Readers, but such as have studyed, to a great degree, either Natural Philosophy, or Mathematicks, or both.

It was requisite that this Theory should not appear, without its Demonstration; that so the Curious might know the Ground, it is built upon; and satisfie the rest of the World, that here is no design laid, to impose upon them; but, on the contrary, such hopes offered, of an extraordinary Success, in raising good and early Fruits, unless the Seasons be too much wanting, as amount al-

almoſt to an intire certainty. Neither could the Directions, that were to be given, be fitly expreſſed, without borrowing from Geometry, and ſome other Mathematical Sciences, their proper Language.

I have endeavoured to be as ſhort, as I poſſibly could: and there are ſome places, where, if one reads faſt, he will hardly conceive the whole extent of the Diſcourſe. Such are, for inſtance, the places, where I ſpeak of Remedies againſt Winds. That very brevity, for which diſcerning Men are uſed to expreſs ſo great an Eſteem, will make a ſecond

reading pleaſanter, leſs troubleſom, and more profitable, whenever it will be neceſſary: and will help to find eaſily, and within a little compaſs, the Directions uſeful to Practice.

As to the Style, I am ſorry to find ſo very few Words, and not one Sentence, to have been altered, by ſuch, as were at the trouble to peruſe my Manuſcript. But the Example of the Illuſtrious Monſieur Hugens, *who publiſhed in French his Theories of Light and Gravity, tho he was no perfect Maſter of that Language, makes me hope that any faults, in the Style, will be forgiven*

given me, especially by English Men; who, of all Nations, have least to reproach me withal, that I should offer to write this Treatise in English. If it be well received, perhaps a second Edition may be more accurately penned.

Most Countries may reap some Advantage, by the Theory, which I shall propose: but especially such, as have more than 45 *Degrees Latitude. This comprehends, in our Europe, all* England, Scotland, *and* Ireland; *most part of* France; Holland, Flanders, Germany, Switzerland; *the North part of* Italy; Hun-

Hungary, Sclavonia, Tranſilvania, Moldavia &c; Poland, Denmark, Sweden, Muſcovy; *and ſeveral other Countries of leſs note: but with ſome difference. Of theſe Countries, ſuch, as lie more to the South, may expect to have, with our Walls, ſome excellent Figs, and Grapes, &c. with ſome of the Fruits of hotter Climates. But as one goes more Northwards, tho here and there ſome new Sorts of Fruits be met withal, yet fewer and fewer good Fruits will, by degrees, be left, eſpecially of thoſe Kinds that require a great deal of Heat; till at laſt moſt Fruits, by the*

the help of Sloping Walls, will only ſhew better their Shape and Bigneſs, and perhaps ſomething of their Flavour, without ever coming to a perfect maturity. For I do not doubt but that, even in thoſe unhappy Climates, the natural Productions, which they have, will be much mended, by our Inclining Walls. Southwards of 45 *Degrees Latitude, I can no more reckon, in the North Hemiſphere, whole Countries, as concerned in this Diſcourſe; but only ſome particular places, upon Hills and Mountains; or elſe ſome peculiar ſorts of Fruits; of which ſome may be made forwarder,*

without any prejudice from the Increase of Heat; and others may be transported, from hotter Countries: Or lastly, some peculiar Expositions; which being yet too cold, as, for instance, the North Expositions, may be helped, as much, as one pleases, by duly inclining their Walls.

As our Theory is not restrained to Europe, nor to Countries on this side the Equinoctial Line; so it is not proper only to Men of great Estates: but whoever is able to have a Wall, about his Garden, may, in some proportion, injoy the Advantage, that arises from it. 'Tis true I have principally considered how

how large Gardens, for Fruit, might be made useful, handsome, and stately. And this being the hardest part, and including all the Directions, necessary to those, that can be but at a small Expence, what I had more to say, in reference to them, was the less considerable. No body therefore ought to complain, that I forgot his Case.

It is not just that we should lay open those rich Presents, which the Author of Nature offers us, without expressing a due Sense of His Magnificence and Greatness. Who can avoid admiring that Supream and Infinite Wisdom,

which makes every where ſuch an immenſe variety, of moſt graceful and excellent Productions, to cover the whole Face of the Earth, and to ſpring out of the very Ground? From thence it is that, notwithſtanding their different Proprieties, they all draw wonderfully their Life, and the Spirit that animates them; to the Amazement of any, that conſiders this ſurpriſing Operation.

Fruit-

THE

TABLE.

Of

Not-

Our

The

And

Some Directions relating to Fruit-Walls.

Slopes

THE END OF THE TABLE.

ERRATA.

PAG. xviij l. 14. THE. p. xxj. l. 21. *Latitudes.* p. 4. l. 28. Neighbourhood. p. 14. l. 30. err. p. 15. In the Note *A Table.* p. 16. l. 22. dos. p. 19. l. 27. *China* tells us, how. p. 23. l. 2. we ſhould gather from: p. 26. l. 23. not to be. p. 29. l. 18. Terraſſe. p. 33. l. 21. Ridings for Fruit might. p. 37. l. 27. proceed. p. 38. l. 10. ſmooth South Wall. p. 43. l. 4. 10593. p. 50. *In the Column of Degrees read* 55. p. 53. *In the Column of Degrees read* 41. p. 54. l. 5. Add in the Margin the following Note if it be wanting: *How to find, in an Air of an uniform Denſity, the Diminution of Heat, for the ſeveral Altitudes of the Sun.* p. 60. l. 6. B A is the Slope. p. 67. *In the Notes* La Quintinye's. l. 27. Begin a new Paragraph. p. 69. l. 2. tryed, about 53. p. 78. l. 5. would. p. 96. l. 29. Canal. *And ſo in the Marginal Note.* p. 104. l. 17. 16. $6\frac{3}{4}$. l. 19. 10. 2 $\frac{3}{4}$ and. p. 115. l. 4. that it has. p. 121. l. 2. In the Notes read *when.* p. 122. l. ult. and. p. 124. l. 29. judgement. p. 127. l. 8. fear yet left. p. 128. l. 4. Frontiſpice.

ADVERTISEMENT.

A Miſtake of one Degree, in the ſuppoſed Latitude of *Paris*, which ought to have been 48 Degrees 50 Minutes, has ſpread thrô the Numbers in the whole 85th Page, and the beginning of the next. But it is eaſie to rectifie this miſtake, which is not very material. If you are minded to correct it;

Inſtead of 49. 183. 781. 427. 548. 427. 121. 548. 121. 487. $4\frac{5}{6}$. 2 Degrees. 49.
Write 48. 169. 773. 460. 595. 460. 135. 595. 135. 527. $5\frac{1}{4}$. 1 Degree. 48.

IN the Latin Mathematical Treatiſe, which will be bound at the end of ſome Copies of the preſent Diſcourſe, the laſt Number in the 21th Page, ought to be 21302584.

To the BOOK-BINDER.

☞ *THE Frontiſpice and the Title Half-ſheets ought to be folded ſo, one within another, as to have firſt two white Leafs; then the Frontiſpice and the Title facing each other. The Garden in Perſpective ought to face the firſt Page; and the large Mathematical Cut ought to face the laſt Page, that is the* 128*th Page. Both theſe Cuts muſt be ſo diſpoſed, as to lie, when unfolded, altogether out of the Book. After the ſame way muſt alſo be folded the ſmall Mathematical Cut. It belongs to the Latin Mathematical Treatiſe, and it muſt face the* 24*th Page, which is the laſt Page of the ſaid Treatiſe.*

Horti Fructuum ædilium feracis Orthographica Delineatio, Spectatore versus Occidentem Æquinoctialem prospiciente.
Hac Tabula Murorum ad Horizontem inclinatorum, Arboribus pandendis ac plenius diutiusque Soli exponendis, exhibetur usus.

S. Gribelin sculp.

FRUIT-WALLS IMPROVED,

BY INCLINING THEM TO THE HORIZON:

OR A WAY

TO BUILD WALLS FOR FRUIT-TREES,

Whereby they may receive more Sun-ſhine and Heat than ordinary.

AFTER all the Application of ſo many Men in all Times and Countries to Agriculture, one would ſcarce have thought there was yet left ſo notable and ſo very obvious an Improvement of it as that I am a going to propoſe. It conſiſts in building Walls for Fruits, Grapes &c, not in a perpendicular Situation, as is commonly done, but ſo ſloping, thô otherwiſe ſtraight and plane, as to receive the Beams of the Sun,

Idea of ſloping Walls for Fruit.

not only for a longer time, but also with a much fuller and better Exposition.

It will appear that this way of building Fruit-Walls will be very advantagious, if we compare perpendicular Walls in several Countries and Expositions with one another, and with sloping Walls: examining withal some of their most considerable Proprieties.

Defects of perpendicular South-walls.

South-Walls are commonly reckoned to be the best for Fruits. But in these Climates, and much more in hotter Countries, when the Days are something long, and the Heat of the Summer is in its greatest strength, it is late before the Sun shines upon them, and the Sun leaves them as early in the Afternoon. When it is about Midday the Sun is so high, that it shines but faintly and very sloping upon them; which makes the Heat to be much the less; both because a small quantity of Rays falls then upon these Walls; and because that very quantity acts with a kind of glancing, and not with full force. Before or after Noon the Rays come yet upon our ordinary South-walls with more obliquity.

Perpendicular South-walls, East-walls, and West-walls compared together.

In the North part of *France* East Walls are looked upon as almost of the same goodness for Fruit as South-walls: which proceeds more from the Defect I have noted in South-walls, than from any particular Excellency in those facing the East. And accordingly South-walls are here, and in all other

other cold Climates, much the beſt of the two. Weſt-walls in *France*, as well as here, are but indifferent, thô they have the like Expoſition to the Sun as Eaſt-walls. I take the reaſon of this difference between Eaſt-walls and Weſt-walls to be partly becauſe in the Morning the Air is purer, and that the Sun ſhines oftener and ſtronger than in the Afternoon; and meets with the Dew while it is yet freſh upon Plants, whoſe motion it revives after a long reſt, and as it were a refreſhing Sleep. But the chief cauſe of it muſt be attributed to the coldneſs of the Air in the Morning, that checks the Vegetation, till the preſence of the Sun revives it; which it dos much ſooner and much more effectually on the Eaſt-wall than on the Weſterly. In the Afternoon the Heat of the Air is great every where; and Heat alone, without any Sun-ſhine, is able to make Plants vegetate, thô not ſo perfectly. Which, if it were not ſufficiently known, might be eaſily evinced from what is obſerved in Summer in the Fields, when the Sun happens not to be ſeen for ſome Weeks together. I ſaid that the Sun ſhines ſtronger in the Morning than in the Afternoon, thô it be hotter in the Afternoon than in the Morning. But this is not becauſe the Sun in the Afternoon ſhines with more force; but becauſe it continues to act upon an Air already warmed with the impreſſion of the Morning

Sun. In order to be ſatisfied in it, one may, when the Days are long, compare nicely the Effects of a burning Speculum at 5, 6 and 7 a Clock in the Morning, with its Effects at 7, 6 and 5 in the Afternoon. For the like reaſon it is much warmer a Month or two after than a Month or two before the Summer Solſtice; thô we cannot but ſuppoſe the Sun to ſhine ſenſibly with the ſame force at equal diſtances from the Tropick.

Perpendicular Walls compared with Sloping Walls.

Conceive a perpendicular Wall with Trees againſt it. It is evident that it is expoſed only to one half of the viſible Sky. And the point to which it is directly expoſed falls upon the Horizon. To which point ſhould we ſuppoſe the Sun to be ſomething near, one half of the time it would be under the Horizon, and the other half it would ſhine but weakly thrô ſo great a depth of Air.

But if we ſuppoſe the ſaid Wall remaining on the ſame place to be inclined, with the Trees againſt it, ſo as to become elevated only 45 Degrees upon the Horizon, and to have the Trees on its upper ſide; the Wall in that ſituation will be expoſed to three quarters of the viſible Sky: and the point to which it is directly expoſed will be 45 Degrees high. To all the Neigbourhood of which place if the Sun happens to come, it muſt needs act from thence upon the Wall with a conſiderable

ſiderable force. And ſo far the advantage of ſloping Walls is already plain and obvious, without any Calculation.

Now if we proceed farther, and bring the matter to a Calculation, according to ſome Principles, which ſhall be explained in a proper place, and which moſt Mathematicians will admit of; we ſhall not only ſay that there is a great advantage in ſloping Walls; but we may alſo ſhew in Numbers, ſometimes exactly, ſometimes by a near Computation, the Increaſe of Heat we ſhall have, by uſing them rather than perpendicular Walls.

The ſame done in a particular Example for the Equinox;

Thus, for Inſtance, if in the Latitude of 52½ Degrees, which is more Northerly by one Degree than *London*, a South-wall, very ſmooth and even, be ſo leaning as to have its Plane paſſing thrô the Pole of the World; which ſloping for many Fruits is not altogether the beſt that might be aſſigned; the Action of the Sun upon it in an Equinoctial Day will be to the Action of the Sun in the ſame Day upon an ordinary upright South-wall (ſuppoſing it alſo to be ſmooth and even) as 100 to 63. And theſe Numbers we can eaſily continue with exactneſs to many more places at pleaſure. So then here the Heat of the Sun is increaſed ſomething more than in the proportion of 3 to 2 (not to ſay of 11 to 7) above what it is in the perpendicular Wall; which is very con-

considerable. But that Increaſe will be yet greater and greater, as the Sun comes to have a greater Northerly Declination.

and for the Summer Solſtice.

For in the Summer Solſtice the Action of the Sun, upon that even and ſmooth ſloping Wall, will be increaſed ſo as to be upon one account more than 3½ times greater than the Action upon the perpendicular Wall. Beſides another very conſiderable addition of Heat, which would make that Action from 3½ to become 4½ times greater, were it not that ſomething is to be ſubſtracted from this laſt number, upon the account of the Light of the Sun not coming ſo freely thrô a greater depth of Air: which Correction has no place in the Equinoctial Day. However we may ſuppoſe the Heat, in the Summer Solſtice, to be about fourfold what it would have been upon the perpendicular Wall.

The reſult of which ſhews the great advantage of Sloping Walls.

This Increaſe of Heat is ſo extraordinary, and for above two Months the Sun keeps ſo very near the Tropick, *viz.* within a diſtance from it of 3½ Degrees, that ſeeing what our South-walls are already able to do, I do not doubt but ſuch a Wall as this would make Grapes, and Figs, and other Fruits equal here in goodneſs to thoſe of ſome much hotter Climates.

What Countries they are beſt for.

Yet I confeſs this improvement for Fruit-Walls is not like to be ſo uſeful here as in *France*, or thoſe other Countries where they enjoy the ſight of the

the Sun oftener than we uſe to do; a due regard being had every where to the natural productions of the place. Nor do I look for any excellent effect from it, unleſs the Trees or Grapes be raiſed from the beſt Kinds, and the Soil be good and deep, and the Trees and Vines be governed and cultivated by a skilful Artiſt. It is too common here to leave theſe Plants to themſelves, and in a manner without any Culture. Whereas, beſides the neceſſary care of Pruning them duly, they do not think it too much, even in Latitudes where they have not the ſame occaſion for thoſe foreign helps, to dig very frequently about them, or to do it at leaſt four or five times in a Year.

A good Culture is neceſſary for them to have their full effect.

Leſt thoſe that deſire good Fruits, and are no proper Judges in an Inquiry that depends ſo much on Geometry, ſhould look upon what I have ſaid as a bare Speculation, I will make them acquainted with the following Story. By which it will appear, that as we have already our Reflexions and Calculations of our ſide, ſo we are not altogether deſtitute of Experience.

Having explained to a Perſon of Quality the preſent Invention of Sloping Walls, I received for anſwer, that upon a Sloping Wall, which I ſaw ſince, and I will deſcribe by and by, there grew ſome Years ago Grapes equal in Goodneſs to thoſe that grow in *France*. This Wall was nothing but a facing of Bricks laid flat (and by con-

An Inſtance from Experience of the uſefulneſs of Sloping Walls.

consequence only two or three Inches thick) upon a natural slope of Earth, about seven or eight Foot high. It was of very many Years standing, yet extreamly sound and intire; except in some few places, where the Brick it self was mouldered away. It had been made only becaus (being very near and directly opposite to the House) it was thought to be handsomer than the naked Earth. It made an Angle of about 60 Degrees with the Horizon; and was exposed not directly to the South, but several Degrees Westward. The Soil is not extraordinary. The House was but low, but it must needs shade that place a great part of the Day. There has been added since some pretty high Buildings to both ends of the House, which Buildings by their shade have intirely spoiled the said Vine, so that it has been pulled up. I felt the Bricks of that Slope one Day, when the Sun shone almost perpendicularly upon them, and they were exceeding hot. But those Noble Persons, to whom the House belonged, thought the goodness of the Grapes might arise from the Soil; and forgetting the Exposition, they never tryed to recover their loss by another Sloping Wall, for which the Ground would have afforded them abundance of convenient places.

And

How Sloping Walls may be built with little charge.

And thus we have not only a notable Experience for us; but we ſee alſo how eaſily and how cheap our Sloping Walls may be built, without any danger of their tumbling down, as our Garden-walls are apt to do. But this being a very material Point, and conſidering that moſt People may think it either very chargeable, or very impracticable, to build a Sloping Wall, let us a little inlarge upon it.

I conceive then that the facing the Slope of Terraſſe Walks, either with a Brick-wall, ſuch as I juſt now deſcribed, or elſe with a Wall twice, or at moſt three or four times as thick is the beſt, eaſieſt, and handſomeſt way of building our Inclining Walls. Whoſe name ought not therefore to miſlead one ſo far, as to make him think, that we would propoſe the building of a thick Wall ſloping and incompaſſed on both ſides with Air. The thicker Walls are propereſt when they are leſs ſloping: for ſo their ſtrength may better ſerve to keep the Terraſſes from breaking out. It is not required we ſhould lay the flat ſides of the Bricks perpendicularly to the plane of our Wall: but it will be more proper to lay them parallel to it: So that each Bed or Floor of Bricks, of which our Wall is compoſed, may be only two or three Inches thick. And thus the Joynts of the Bricks may be ſo diſpoſed as to leave no room for Plants or Inſects to come out of the Ground.

And how far the Roofs of Houſes might ſerve inſtead of Sloping Walls.

After having explained a better way, 'tis hardly worth our while to obſerve that the Roofs of long and low Buildings in the Country, and even the Roofs of Houſes in great Towns, might alſo conveniently be made to ſerve for Sloping Walls; eſpecially if ſome regard were had to it in building. So, for inſtance, in the Country the Roof of a long Building might on one ſide be brought as low as the very Ground. And thus Trees and Vines, eſpecially the laſt, might be made to grow againſt the Roof, without ſpending their very ſtrength in growing up to an immoderate height. In Cities, where they uſe ſometimes to make one Roof to ſerve many Houſes of one ſide the Street, one might, between the Garret Windows, cut out in the Roof a rectangular Space, of the ſame height and breadth with the Space the Windows take up; and from within one might ſlide up to that Space a ſquare Box full of Earth, of a fit Figure and bigneſs to ſtand handſomly between the Windows. This Box being ſupported at ſome height from the Floor, one need not fear any inconveniency from the Water's dropping out: which, in caſe it ſhould do, might be received in ſome Veſſels. It is ſo eaſie to prevent the Rain from running in, between the Roof and the Box, that it is to no purpoſe to inlarge upon it. Out of theſe Boxes one might raiſe ſome excellent Trees and Vines,

and

and ſpread them upon ſome Frames diſpoſed againſt the Roof. And this, beſides the more ſubſtantial Advantage of yielding a conſiderable quantity of Fruit, would alſo prove a delightful Ornament to that part of our Buildings, which ſeems to want it moſt. However at *London* the Smoak of Sea-coal is much to be feared; ſince it both takes off the ſtrength of the Sun, and dos ſettle upon Trees, where its great acrimony muſt needs be unnatural and pernicious. But I muſt give over and leave the Application of this Doctrine to every body's Induſtry.

I need not mention that, in the making our Bricks, ſome holes may be made in them to receive Pegs of Wood to ſerve as neceſſity ſhall require: unleſs you chuſe rather to uſe thoſe Frames the French call *des Eſpaliers*; which indeed ſeem to be much better. But it is worth obſerving, that ſuch Walls as theſe, having no Foundation, leave in the Earth more room for the Roots of our Trees; and are cheaper built and leſs apt to fall. If they be not made both exceeding heavy and little ſloping, I do not think that they will compreſs ſo much the Ground under them as to obſtruct the growing and ſpreading of the Roots. And thus much is ſufficient as to the manner of building our Walls.

The Advantage of their having no Foundation.

Let us now see, as far as we can, how we may chuse, in any Latitude, the propereſt Elevation for our South Wall, and for the Fruit we design to raiſe.

Rule for determining the quantity of the Inclination of Sloping South-Walls.

In order then to determine what Slope is beſt to give, in cold and temperate Countries, to our South-wall, I look for the Sun's Meridian Altitude at leaſt ten Days, or a Fortnight, or three Weeks, *&c.* before the latter half of the Fruit of the Kind I deſign to have uſes to be ripe: and then I make the Complement of that Altitude, to 90 Degrees, the meaſure of the Elevation of the Wall above the Horizon. However I would not be tyed by this Rule, but that I might alter, upon the leaſt conſideration, the ſloping of the Wall by ſeveral Degrees; eſpecially if one be afraid of taking in too much Heat. And if the Sun's Declination, belonging to the Meridian Altitude found by the Rule aforeſaid, ſhould be otherwiſe, I commonly reduce it ſo (in our Northern Climates) as to make it fall in the Space, which is from the Equator to the Parallel that goes thrô the 16*th* or 20*th* Degree of North Latitude. The longer the Fruit is a growing ripe, and alſo the more diſtance of time there is between the firſt and the laſt ripe Fruit of the ſame Tree, the more Days would I allow backwards in the finding the Sun's Meridian Altitude, and Declination: Indeavouring by this to make, for the moſt part, the ſtrongeſt Heat of all to fall

ſome-

ſomething before the middle of the ripening time. For the Degree of Heat, that ariſes barely from the Expoſition, is during many Days ſenſibly the ſame, and as it were at a ſtay, when it is at the greateſt. And we muſt, for the moſt part, indeavour that, when our Tree makes an end of yielding its Fruit, eſpecially if this be about the latter end of the Year, the Sun may already, by changing its Declination, have been withdrawing it ſelf ſome 5, or 10, or 15 Degrees from the Line perpendicular to our inclined Plane. Thus all the while the Fruit is growing ripe it will injoy the greateſt Heat.

But let us inquire more particularly after the Limits of the Elevations of South-walls: ſo that we may reſolve to keep them, in each Climate, within the two Extreams we ſhall find.

I ſhould not eaſily chuſe to make any where, except perhaps in extraordinary high Grounds, the South-wall more ſloping than an Elevation of about 30 or 40 Degrees upon the Horizon would make it to be. For, thô a great obliquity of the Wall would not hinder Vegetation, but rather, for ought I know, forward it; yet, our experience in this kind being ſo very narrow, I cannot know otherwiſe, than by gueſs, how the Elevations of only 10 or 20 Degrees upon the Horizon would agree with Plants. However ſuch ſmall Elevations are not fit for South-walls, in theſe Coun-

Of Sloping-Walls in very hot Countries.

Countries. But, if there were any uſe for our South-walls in the Torrid Zone, as there may poſſibly be for thoſe Fruits, which, being peculiar to that Climate, require alſo a great deal of Sunſhine to bring them to perfection, eſpecially in the higher Situations, upon ſome Hills or ſome Mountains, I ſhould even there chuſe not to give theſe Walls leſs than 40, or 45 Degrees Elevation: which ſloping would perhaps give but too much Heat. For there is ſome reaſon to doubt whether it would not ſcorch any Plant whatſoever, that is ſet, in theſe hot Countries, againſt a Wall very much inclined. So I ſhould leave the moſt ſloping South-walls for the Climates that have about 40, or 45 Degrees Latitude: and not uſe them there neither, but upon Mountains, or for the Plants of hotter Countries. In *Iſeland*, which is placed under the Polar Circle, the inclined South-walls muſt make an Angle of more than 46 Degrees, and leſs than 66½ Degrees with the Horizon. Generally, in all the temperate Zone, I ſhould limit the Elevation of the South-wall between 30 and 66 Degrees. Theſe ſeveral Conſiderations muſt be duly weighed together, as well as the tenderneſs of your Plants, in order to chuſe a properer Elevation. But a ſmall errour in this is not of great conſequence, if you intend to raiſe all the Heat poſſible. For you can indeed erre conſiderably but one way, to wit,

wit, in procuring too much Heat. If you do not fear to exceed in this, you may follow the Numbers of this Table; where the first Column gives the Latitude or Elevation of the Pole;

A Table giving the Limits of the Elevation of South Walls in Temperate Countreys.

Latitude. Deg.	Greatest Elevation of the South Wall. Deg.	Least Elevation of the South Wall. Deg.	Least Elevation corrected. Deg.	Middle Elevation. Deg.
40	40	20	30	35
50	50	30	35	42½
60	60	40	40	50
70	70	50	50	60
I	II	III	IV	V

The second Column gives the greatest, and the third Column the least Elevation of the South Wall upon the Horizon. The fourth Column gives the same least Elevation, with some Corrections, that are not made in order to increase the Heat, but, at the expense of some Heat, to give (in smaller Latitudes) more Elevation to the Wall. The fifth Column gives only the middle Numbers between those of the second and fourth; never differing from them one way or another more than 10 Degrees. The Table was made from this Rule, That the Elevation of the South Wall, in temperate Countries, ought, in

in order to make the most of the Sun's Heat, neither to be more than the Height of the Pole, nor less than the Height of the Pole wanting 20 Degrees.

So then the second and fourth Column may pretty well serve, especially in great Latitudes, for Limits of the Elevations of our warmest South Walls. But the Elevations, for hottest Countries, cannot be so well determined, till Experience has taught what may and what may not be done there. In those hot Climates the Rule I gave just now is of little or no use. For it supposes that Fruits are ripe by the end of *October*, or long before. But in the Torrid Zone we may have Fruits all the Year round. In great Latitudes the Sun in Autumn and Winter shines seldom, and always thrô a great depth of Air; which inclines one to neglect that insignificant Sun-shine, and to make the most of the Sun-shine in the Spring and Summer; by keeping the South Walls, as our Rule does, rather more sloping than they needed have been otherwise. But pretty near the Equator the Sun comes every Day to a considerable Height. And that invites one not to neglect the Sun-shine so much during Autumn and Winter, and by consequence to make there the Walls rather less sloping. Which the scorching Heat requiring also, all these Reasons seem to prove that the South Walls must again grow ra-

It is difficult to determine those Limits in very hot Countries.

rather more upright, as one comes nearer the Equator. For let it ever be remembred to consider whether the Climate, the height of the Situation, the Soil, the Exposition, the Nature of your Plants, and the Season of their growing be such as to permit you to give your Sloping Walls the most Heat you can procure.

The Use of the Table.

As to the Use of the Table, the Fruits that ripen in Autumn, and very late in the Year, require the greatest Elevations; those that ripen in *June*, or *July* the least. Such as grow ripe in *May* will have almost the least Elevations: and such as grow ripe in *April*, *August*, and *September*, require some middling ones. But if any Fruit, such as Pease &c, are to grow ripe in *March*, they require again the greatest Elevations. Now all this is said upon supposition that you are in no fear of procuring too much Heat. And this is what we can at present determine about the Limits of the Elevations of South Walls.

Vines are commonly planted upon a rising Ground well exposed.

Before we proceed farther, should not we relate, as an Experiment favouring our Inclined Walls, that where Vines do grow in the open Air, they chuse to Plant them not upon a flat, but upon a rising Ground, exposed to the East, or South-East, or South? Which sloping of the Ground, consonant to the Theory I have been proposing, is found by Experience to be of

an extraordinary Advantage. And to this muſt alſo be referred what Monſieur *La Quintinye* has writ concerning the Expoſition and Declivity of the Ground for great Gardens. But, if after all there ſhould be left ſome Scruples in the Reader's Mind, let him either examine the Demonſtrations I ſhall give in this Diſcourſe, or cauſe ſome proper Judge to tell him how far he may rely upon them.

Having then no reaſon to think, but that our Theory will be found agreeable to Nature, we may ſee farther how it can be brought to an extended and eaſie Practice.

A Hill well expoſed cut into Terraſſes with Sloping Walls for Fruit.

If any body therefore is deſirous, particularly in a Country not expoſed to ſome returns of Froſt in the Spring, and to blaſting Winds, to raiſe a pretty deal of good Fruit, either for his own uſe or for the Market, I would adviſe him, both as the beſt and the leaſt chargeable, to chuſe, in a very good Soil, eſpecially in the ſide of a narrow Vale, a convenient Hill or Riſing, with a pretty ſtrong Aſcent, and expoſed to the South South Eaſt, or to the South and by Eaſt, or to the South, or to the South and by Weſt, or at leaſt not far from theſe Expoſitions: and to diſpoſe his Ground by Terraſſes, one above another, ſo that, in the Latitude of *London*, the ſloping of the Terraſſes be elevated upon the Horizon, for the South Wall, neither leſs than 36, nor

nor more than 52 Degrees. See the Figure I, *Fig.* I. where the Section of those Terrasses is represented, in two several Places, to the Eye. And here you may take notice that, if the Ground be not very steep, the less the Sloping Wall is elevated upon the Horizon, the less Room, all things being alike, each Terrasse will take, and the less charge will be required. In the making of these Terrasses a sufficient quantity of the good Earth must be carefully gathered along the Ridge of each Walk, there to receive and nourish the Roots of our Trees. Neither is it necessary to be very curious in keeping your Terrasses, or Sloping Grounds, straight and parallel. But you may follow the winding of the Hill, provided it keeps within the extent of good Expositions: and take every where so much breadth as dos most conveniently give your Terrasses the Height you require. Thus the Expence will not be considerable; and even the plain Countrey Man may not think it above his power; especially if he dos his Work by parts, and in several Years. And I am much mistaken, if even those irregular Terrasses do not prove very pleasant and entertaining to the Eye. A late ingenious Account of *China*, tells us how agreeable the prospects of their Hills are, which the Country Men divide into several Levels, parted by a Sloping Ground between. All

Something like this done in China, *but for another reason.*

this trouble is taken, in that induſtrious Country, in order to keep the Rain from running off their Fields. But here we ſhall have probably more occaſion to think how we may not be troubled with too much Water; and how that of the upper Terraſſes may be prevented from falling into the lower ones: which being always eaſie to be done, and the Remedy depending, in a great meaſure, upon the Extent of the Ground, I muſt here forbear any farther Diſcourſe.

Thus have I brought our Theory to ſome conſiſtence, and ſhewn how it might eaſily be reduced to Practice. But while the firſt Figure is under our Eyes, I cannot but obſerve, that inſtead of looking with others upon a great Declivity towards the South as a conſiderable inconveniency in the Ground for a great Garden, I ſhould rather admire it, for the multitude of Sloping Walls, well expoſed, it would afford from place to place; beſides the pleaſantneſs of many Walls breaſt high, and of a good proſpect abroad. And as to the ſhade for Walks, one might have it at the top of all from ſome rows of Trees.

Fig. I.

A conſiderable Declivity to the South in a large Garden may be turned to much advantage.

I will here add ſome Reflexions, I chuſe among a great many, by which we may farther compare Inclined Walls with perpendicular ones. For I ſhould ſwell this to an unreaſonable Bulk,

ſhould

ſhould I ſpeak of all the Calculations I have made relating to this matter. I ſhall only then obſerve that, from the Equator to the very Pole, that is in the whole Terreſtrial Globe, I find not one Place, and not one Expoſition whatſoever, in which a perpendicular Wall is ſo hot as a Wall ſloping to a proper Degree for the Expoſition. And, whereas the North Expoſition is utterly naught, in our ordinary manner of building perpendicular Walls, if in the Latitude of 51½ Degrees a North Wall be elevated only 38½ Degrees upon the Horizon, it will injoy the Sun, thô much ſloping, for every Minute it can ſhine in the whole half Year, from the Spring Equinox to the Autumn Equinox. But during the two Months and three Days about the Summer Solſtice it will injoy the Sun with an Elevation, or Inclination, ever greater than of 20 Degrees: which gives more than the ninth part of the full Action of the Sun. And for ought I ſee that may be near as much as our ordinary South Walls do then receive. This might ſerve for the Summer Fruits that are ripe about the end of *July*, and for raiſing of Peaſe, &c. For thô one would not chuſe to build ſuch a Wall without ſome neceſſity, or ſome other conſiderable advantage, yet having it at hand one would not leave it without uſe. The North Expoſition dos mend very faſt as the Countrey lies

A perpendicular Wall in no Countrey ſo hot as a Sloping Wall proper to the Place and Expoſition.

The North Expoſition is made tolerable by a Sloping Wall.

lies more Southerly: And above all others it dos require, in temperate Countries on this ſide the Equator, Walls with a very ſmall Elevation, ſuch as 25, or 30, or 35 Degrees. So then we find that even the very worſt of perpendicular Walls may become tolerably good, if they be made ſloping.

It will appear, by the ſequel of this Diſcourſe, how many Advantages, beſides the bare Increaſe of Heat, do follow our building of Sloping Walls: But one of them lies already too obvious not to be ſpoken of here.

Uſe of Sloping Walls for having Fruits, Melons &c, early and thoroughly ripe.

I ſay then that this Contrivance ſeems to be of an extraordinary conſequence, for the raiſing of all ſorts of Fruits ſomething earlier than we uſe to have them, and for their perfect ripening: And that it may prevent ſome of thoſe, that are fond of Fruits, from falling into the Diſeaſes that uſually follow the eating Fruit not thoroughly ripe. I expect from theſe Walls ſuch Melons, and Figs, and Grapes, as, I think, have never been ſeen in this Country. I forbear ſpeaking of other Fruits; but ſhall only ſay that, if we had once ſome excellent Kinds of Trees raiſed by this Method, we might not need to ſend for new Graffs again to *France*. And if, the Summer being extraordinary wet and cloudy, our Sloping South Wall ſhould bring forth but indifferent Fruits, yet even then thoſe Fruits will be

be more tolerable than ſuch as we gather from our ordinary Walls. But all this will become more evident, when the Principles I build upon ſhall be laid down.

There is yet ſomething I have to ſay, both in reference to the propereſt matter to build our Walls withal, and to ſome other circumſtances in the manner of building.

As to the propereſt Matter for our Walls, I think Brick to be much better, in this Countrey, than Stone: becauſe they grow hotter, and keep much longer the Heat. By which means they do ſtill warm the Plants a good while after the Sun is hid under a Cloud, and, in a manner, loſt to other Walls. I know nothing that is more convenient than they are, or of a better Shape for our purpoſe. The biggeſt and thickeſt Bricks will be beſt: And I ſhould chuſe, as I ſaid before, to diſpoſe them ſo that they might appear by their broadeſt ſides. Thus the Wall will be cheaper, the Bricks will be apt to grow warmer, and, their Interſtices being fewer and leſs deep, there will be leſs room to take care of againſt Inſects finding a ſhelter there. Walls of Slate, or of any dark coloured Stone, whether natural or painted, will alſo be very good. For theſe Colours imbibe the Light, or Heat, much more than Colours that are whiter.

Walls of Bricks are beſt in England.

Of Walls of Slate, or of any dark coloured Stone, whether natural or painted.

Our

Sloping Walls not to be clogged with any Shade, except perhaps in Winter, or when the Sun is very low.

Our Walls ought not to have any Building raiſed from the top of them; nor any other Shade caſt upon them in Vegetating time, by the Interpoſition of any thing ſtanding, on either ſide of them, between them and the Sun. But if they be deprived of the ſight of the Sun, while it is only within a few Degrees from the Horizon, the loſs is not conſiderable, and abundantly made up, if, at the ſame time, they be ſecured from Winds.

Sloping Walls may aſcend obliquely upon a Hill; and the uſe of making them ſo.

The Foundation, or rather Bottom of Sloping Walls needs not be horizontal; but it may aſcend obliquely upon a Hill by ſome Degrees. Which is of ſome conveniency for the running off of the Water, and for the chuſing a South Expoſition upon a Hill that looks to the South-Eaſt, or South-Weſt, or to any other point, either between, or, at leaſt, not much above 45 Degrees diſtance from theſe places. For the moſt part of the Spring and Summer ſuch a Wall will injoy as much Sun, as if the Foundation had been horizontal; but the Ground at the Foot of it will injoy leſs. And this is what I had further to mention as to the way of building our Sloping Walls.

Many Slopes in ſeveral Gardens are ready made, and fit for Sloping Walls.

I have ſeen, in many Gardens, and other places, ſome Slopes of Earth ready made, and fit every way for Trees to grow againſt them, if they had been but faced with Bricks. But they lay

lay neglected, perhaps becauſe the good Uſe that might be made of them was unknown.

The goodneſs of a Wall proved owing in a great meaſure to the Expoſition.

If any were apt yet to think that there can be no great difference between two South Walls, of which the one receives the Light of the Sun much fuller and longer than the other; let them conſider that, upon the very ſame Soil, the South-ſide of a Wall is as good for Fruit as the North-ſide is bad. That the Eaſt-ſide of another Wall is very good, at leaſt in *France*, and the Weſt-ſide but indifferent. Which diverſity can certainly be attributed to nothing but the Expoſition; and makes it more than probable that by ſo much as this is mended, by ſo much Fruits ought to be more perfect.

The Author's Deſign in commending this Theory.

I have given to this Theory ſome of the Commendations it juſtly deſerves, knowing how hard a matter it is to perſuade People to go out of their ordinary way: And I wiſh I may have ſaid enough to bring it into common Practice. I hope this is not out of any vain Oſtentation, ſince I chuſe to publiſh here what I know to be much inferiour to ſome Meditations of another Kind, I have had theſe many Years by me. And thus much I beg leave to ſay; leſt a thing that might be uſeful ſhould be neglected and thrown by, before it be underſtood.

The Advantage for Vegetation of a close and warm Air; and of small and narrow Gardens.

If the vegetation of Plants did only depend upon the Sun-shine coming freely to them, there would be but little occasion left for any farther Improvement. But it is well known that a warm and pretty close Air, well sheltered from Winds, thô not so much exposed to the Sun, in a word, such an Air as is found in the Gardens at *Paris*, and other great Cities where they do not burn Sea Coal, dos often bring forth better Fruit than will be found in other places, in the Neighbourhood, thô better exposed. However, at the same time that we get wholly the advantage of Sloping Walls, we may also keep all others, and secure those Walls from cold and dangerous Winds. This makes me recommend Gardens of but an indifferent bigness, with high Walls to them: being willing to purchase a close Air with some little loss of Sun-shine. But if the Gardens be very narrow, as I should for the most part chuse, the Walls may be less high. The breadth of your Gardens ought not be the same in all Expositions. And it is of great consequence that the length of very narrow Gardens be from East to West, and not from North to South. In disposing thus the length of the Garden, the Wall may be from 8 or 10, to 15 Foot, or a little more, in the Slope: the breadth of the Garden, or Earth, between the Walls, from 11 or 12, to 50 or 100 Foot: and

and the length as great as you pleaſe. But the ſmalleſt Breadths are beſt: And thoſe, as I ſaid, do not ſo much require high Walls: and by conſequence will not be ſo chargeable. In Gardens that run from North to South, a very ſmall Breadth will be as prejudicial as it is good in Gardens that run from Eaſt to Weſt. For it is eaſie to ſee that, in theſe laſt, the Shade of the long Walls upon each other is but little, in vegetating time; and falls either upon the ſhorteſt Days, or upon ſuch Moments as the Sun is but low and weak. But, in Gardens that run from North to South, and are of the ſame breadth with the former, the Shade is more conſiderable. 'And 'I find that ſuch Gardens, having an Eaſt Wall 'and a Weſt Wall, each with an Elevation of 30 'Degrees, and each of 7 Foot in perpendicular 'Height, muſt be 68 Foot wide, from Wall to 'Wall, if you will that neither Wall ſhould take 'from the other the ſight of the Sun, but when 'it is leſs than 5 Degrees high.

Leſt any one ſhould wonder at this extraordinary narrowneſs, which dos often turn what we called a Garden into a narrow Walk, I will ſhew that I do not chuſe it without ſecuring that great advantage of a warm and cloſe Air: In order to which I give here the Section of a Walk, or narrow Garden for Trees, whoſe length runs Eaſt and Weſt. Let the South Wall AB have a *Fig.* II, III.

How to make some Terrasses running from East to West, so that the Air between be extreamly warm;

proper Elevation for your Climate, and for the Fruits you design to have; suppose at *London* an Elevation of 45 Degrees. That Elevation is good for those Trees, whose lateſt Fruits are ripe near the 20*th* of *September*, 'when the Sun is about 3 'or 4 Degrees South Declination: at which time 'the Sun is already withdrawn about 10 Degrees 'from the perpendicular to the Wall AB. Let the perpendicular Height BC of your Wall be for Inſtance, of 7 or 10 Foot; 'which will give '9,9, or 14,1 Foot in the Slope AB, and 7 or '10 Foot in the horizontal Line AC. Let the Line AD be in the Plane of the Equator: and it will make here at *London* an Angle of 38½ Degrees with the horizontal Line AE. Make the Breadth of your Walk the narroweſt you can. Allow, for Inſtance, four Foot to the Ground that is to receive the Trees, and to be now and then cultivated: three Foot to the Walk or Path; which ought, of right, to be dug up every Winter: four Foot more to another Line of cultivated Ground. So you will have 11 Foot for the whole Breadth of your Walk AE. Draw from the top B of your Sloping Wall an horizontal Line BDG. Draw alſo the Sloping Line EG, repreſenting your North Wall, and make it, if you pleaſe, parallel to the Plane of the Equator; or rather, if you think fit, make it yet more inclined to the Horizon, I mean more

more approaching to it, by ſome 10 Degrees. Make the tops of your Terraſſes G H, B I, of what Breadth you pleaſe; ſuppoſe of 1, 2, or 3 Foot. But they muſt be broader if you intend them for Walks. Draw the new Slopes H K, I L, either parallel to B A, G E, or elſe with what alteration you think convenient. And ſo you have two Terraſſes; to which you may, upon the ſame Level, and at convenient Diſtances, add as many more as you pleaſe. Now it is evident that the Heat of the Sun, being at the ſame time reflected, in the Spring and Summer, by both the Walls, will warm extreamly the Air A B G E; and, in all probability, give a much cloſer Heat than is in great Cities: eſpecially if, to break the Winds, you have, from diſtance to diſtance, another Teraſſe running from North to South, between thoſe I have deſcribed. Theſe Terraſſes have a double advantage againſt Winds, in that they receive them more ſloping, and alſo reflect them upwards: So that the firſt Terraſſes are a pretty good Shelter to defend the following ones. If the Ground be falling or hanging towards the South, the top G H might be kept lower than the top B I; or the contrary done if the falling be to the North and but little. For I would chuſe, except in hot Countries, to avoid any other North Expoſition.

and that they be not expoſed to Winds.

In

In caſe you ſhould deſire to make your Walls higher, you might, for inſtance, increaſe by a quarter the Lines in each of the Figures; or elſe increaſe them in any other ſuch proportion; and keep the ſame Inclinations as before. 'So you 'might make A B of 13,2 Foot, and A E of 14,7 'Foot; or elſe A B of 18,8 Foot, and A E of 14,7 'or 20 Foot. Only the cultivated Ground needs not exceed 5 or 6 Foot; and the Path may be accordingly increaſed as it lights.

Terraſſes to be made higher when they are far aſunder.

On the other hand, in caſe your Walk be made a pretty deal wider, it would, at the ſame time, be proper that your Sloping Walls ſhould be made higher, thô in a leſs proportion than the Walk is increaſed. And this is in order to procure more cloſeneſs to your Air, and to have both more Sun-ſhine and a better Shelter againſt Winds. So, for inſtance, if you make your Walk four times as broad as it was ſuppoſed in the ſecond and third Figures, and your Wall higher only in the proportion of 4 to 3 than it was already, the Foot of your Wall would not, after that change, loſe half the Sun-ſhine it ſhould have loſt before. And the Sun, of which it would be deprived, being ever very low and oblique, it would yet amount to much leſs as to the loſs of Heat: Eſpecially almoſt all that loſs falling upon the ſhorteſt Days, and coming to nothing near the Equinox.

But

But those extraordinary Banks would perhaps be more chargeable, as they would also be more lasting, than two bare Roofs, like those of Houses, and supporting, instead of Tiles, a Brick Wall. Which Roofs would also yield under them a Space that might be turned to some use. The greater those Banks or Roofs are, the greater is the quantity of Rain brought to the Foot of them; and the closer and stronger is the Heat. Unless, for the conveniency of a Garden between, you should remove them farther asunder. Such a Walk as I have described would also be good for raising in it those rare foreign and Medicinal Plants, that require more Heat than the Climate dos give. And I don't doubt but Orange Trees may grow there in the nature of Standards, provided, in Winter, the place be secured from Cold: which is not impracticable. However we have what we aimed at, the closeness of Air, and Walls pretty well secured against dangerous Winds.

Roofs may be used instead of Terrasses.

Of Plants of hotter Countries.

Of Orange Trees.

I cannot here dissemble some faults of our Sloping Walls. For, as they have several very great advantages, so on the other hand there is in them some inconveniencies, which I could heartily wish were otherwise. However these last are not at all able to ballance the former; as will easily appear to any one that reads impartially this whole Discourse.

Of some Objections against Sloping Walls.

Let

Sloping South Walls exposed to the mischiefs of latter Frosts, unless prevented.

Let me first mention one very considerable Objection, against our Sloping South Walls, in those cold Countries, where the passage, from cold to fair Weather, is not, as in *Denmark*, quick and certain; but the Air is subject, as here, to some returns of Frost, after it has been fair for a good while. And that is, that the Heat of these Walls will probably make the Blossoms of some Trees to come out too soon, and expose them to an evident danger of being spoiled by the latter Frosts. To this Objection I have little to say, but that it dos already grant a great deal in favour of our Walls: and that we may take our chance, as others do; there being but a few Days more of danger, for our South Walls, than for those of other people; whose Blossoms are like enough to be spoiled when ours are. Let us also remember that, in those Climates, a kindly and natural forwardness, together with a perfect maturity, owing not to our artificial Fires, but to the light of the Sun, is hardly to be had, but at the rate of running that hazard. Let us then, as I said, try our Fortune; and in the mean while use, if we think fit, all the Remedies Agriculture dos afford, to keep back this early Vegetation, and to prevent the mischiefs of Frost: for which I refer you to the proper Authors. * However here is an easie Remedy we may use, not only against this too great forwardness, but also against Winds. Sup-

Of Remedies against an early Vegetation and Winds.

* *See La Quintinye.*

Suppoſe we make but few parallel Terraſſes, all of them running from Eaſt to Weſt, for inſtance, but two, or four, &c. Let, in the II Figure, AB repreſent the South Wall of the Northermoſt Terraſſe, and EG the North Wall of the Southermoſt Terraſſe. Prolong upwards, indefinitly, the Lines AB, EG, in M and N; and prolong alſo the Horizontal Line EA Northwards in O, and Southwards in P. You may fill all the Angle MAO with Trees, and very tall and thick Hedges &c, without any injury to the South Wall AB, and the Angle NEP, without any injury to the North Wall GE. And yet both the Walls AB and EG will, for ſix Months together, enjoy the Sun-ſhine, for twelve Hours or more. Now this Remedy is better againſt Winds, and againſt the forwardneſs of bloſſoming, than againſt the forwardneſs of Fruits; and, by conſequence, is ſo much more to be valued. Thus ſeveral Ridings might be made in a large Foreſt; provided the Ground were not already worn out; or that it were put in heart again. *Fig.* II.

Sloping Walls are expoſed to one ſort of white Froſts.

Another Objection againſt our Sloping Walls, is, that in the Spring, in ſome cold Mornings, the Dew may ſometimes fall, in great plenty, upon the Bloſſoms, and there freeze, as it falls; which might endanger them, and blaſt all our hopes. I confeſs, I do not know how far this miſchief is to be feared. But this I may ſay,

that, in the coldeſt part of the Spring, the Sun ſhines upon our Terraſſes, from the time it begins to be ſome few degrees high; and, by conſequence, ſoon after the Dew is fallen. So that there will be no time, at leaſt in fair Weather, without which we have commonly no Dews, for much harm to be done: Eſpecially the Vapours, or Steams, that ariſe from the Ground, being more like to diſperſe in the Air, than to condenſe againſt our Trees; as I ſhall explain hereafter. However this inconveniency being already too much felt in ordinary Gardens, the Remedies againſt it are found, and well known; at leaſt by ſuch as raiſe ſome early and tender Plants, at the latter end of Winter.

They are much expoſed to Hail.

Our Walls are alſo more expoſed to Storms, and Hail, than ordinary Walls. Yet this ought not to deter us. For we ſhall not have this accident every Year, at ſuch times, when we may fear it. And, if we ſhould have it, yet it is to be ſuppoſed that many of our Fruits will eſcape being ſpoiled. Neither is it impoſſible to cover ſuch Trees, as are moſt precious, when there is any proſpect of a Storm.

Of the Trees growing obliquely to the Ground.

I expect ſome will object alſo, that, the natural poſture of Trees being to grow upright, their leaning againſt a Bank will be like to diſagree with their Vegetation. But this Objection has not that ſtrength in it, which is in the for-

former; and might well have paſſed under ſilence. For it is a common thing, in our Gardens, to force Trees into a Figure not at all natural to them. And even Trees, that grow in the open Air, have ſome of their Branches bending downwards; and moſt of them in a manner parallel to the Horizon. It was ordered wiſely, for the beauty and ſtability of Trees, but not for their fruitfulneſs, that they ſhould naturally grow upright. Now theſe firſt conſiderations ceaſing, in an Inclined Wall, I do not doubt but that, as to the production of Fruit, Vegetation will have there its ordinary courſe.

Of the dampneſs that may be objected againſt Sloping Walls.

It has been twice objected to me that the dampneſs of the Ground would probably ſpoil the Fruits growing againſt our Sloping Walls. Which makes me take notice of this Objection, for otherwiſe I ſhould have neglected to give it an anſwer. I ſay then that either this inconvenience is not at all to be feared; or, if it be, that the Remedies are obvious and eaſie. I do not fear it in ſuch Terraſſes as thoſe of the II, III, and XI*th* Figures; eſpecially when they are well expoſed. For I cannot ſee what mighty ſtore of Dampneſs can come, or be kept there; ſince water naturally runs off of ſuch heaps. But as to the lower Terraſſes of the firſt Figure, if one or two beds of Bricks be not enough, at leaſt three or four ſuch Beds, and what elſe one

pleaſes underneath, will be ſufficient to make the Wall remain dry at the outſide. Moreover it is not neceſſary that the Fruit ſhould touch the very Wall. But in caſe it ſhould grow too cloſe againſt it, a thin Slate, or a ſmall Ring, of any proper matter and ſhape, will eaſily keep it from the Terraſſe. After all I think Expe-rience, to which I muſt appeal, will add no ſtrength to this Objection.

Of their being expoſed to Mice and Ants, &c.

Some have urged, againſt our Walls, that our Fruit will be eaten up by Mice, or by Ants, &c. Thô I might ſay that all other Trees are expoſed to this very miſchief; for 'tis known that thoſe Mice and Ants can eaſily creep upon them, yet to this, and all other Objections, I will give but one general Anſwer. I ask whether the inconvenience that is objected be real, neceſſary, general, and unavoidable? or elſe whether it be not, in a great meaſure, imaginary? I ask whether there be no Remedy left againſt it to our Care and Induſtry? I ask, when all is granted to the Objection that can be given it, whether there will be nothing at all left for us, but Trees without Fruit? 'Tis true that I ought by ſo much more to fear the reſort of Inſects to our Fruits, as they are like to prove more excellent than others are. But it is well for us that the firſt Inventers and Improvers of Arts have not at all been moved by ſuch Objections

Of all other Objections againſt them.

as

as these. Are they greater than such as may be made against a Countrey-man, who would sow his Grounds? How is he secured against the vexations of troublesom Neighbours, against the Invasions of an Enemy, the mischiefs of Civil Wars, the unfaithfulness of Servants? How can he depend upon fair and seasonable Weather; without too much Drought or Rain, without Hail and Storms and strong Winds? May not his Seed be eaten up in the Fields; may not his increase be stolen away from him; or destroyed by numberless sorts of Insects? What shall I say of the mischiefs of Fire? What of Taxes and Tithes? What of the price of Rents and Leases? What of selling one's increase to such as will not, or cannot, pay their Debts? What of all other fears and troubles that may come upon this poor Countrey-man? Yet for all this, our Fields are ploughed, we are nourished, and our Barns are filled with Grain. Such is the Profusion, with which God Almighty provides for us, that, after all deductions made, we have enough to bless his Munificence, and to live with plenty.

Now having, in some measure, satisfied the curiosity and impatience of the Reader, I may proceed to shew how I calculate the proportion of Heat, I gave before, between a Perpendicular and a Sloping South Wall; and treat at large of the Prin-

Principles and Method, upon which those, and the like Calculations, are grounded: endeavouring to make our Doctrine as general and as exact as the Nature of the Subject will bear.

Calculation shewing for an Example the proportion of Heat at the Solstice, in the Latitude of 52½ upon a perpendicular Wall, and a sloping smooth South Wall, passing thrô the Pole.

I begin with Calculating, for the Parallel that lies one Degree North of *London*, the proportion between the Actions of the Sun, in the Summer Solstice, upon a Perpendicular, and upon an Inclined smooth Wall, with an Elevation of 52½ Degrees; which is an Inclination very good there, for the Fruits that are ripe in the Month of *October*, or the latter end of *September*. For other Fruits that Elevation is rather of the greatest.

Fig. IV. *The Ground and Method of this Calculation.*

"The Circle PTEP described from the Center C represents the Celestial Sphere. CH is the "Horizon; P the Pole; CE the Equator; IT "a Parallel to the Equator, as suppose here "the Tropick of *Cancer*. CIP is the Plane of "the Inclined Wall C*i*; CM the Plane of the "perpendicular Wall C*m*. Upon the Circumference of the Parallel TI I suppose a right Cylindrical Surface elevated and prolonged of each "side as far as is necessary: Which I do in order to find upon it the proportion of the Sun's "Heat.

'Now it is easily known that the Quantity of 'Rays, falling from the Sun upon any Plane, is as 'the Sine of the Sun's Altitude on that Plane.

'And

'And that the Force of each Ray, coming from 'the Sun upon a Plane, is alſo as the Sine of the 'Sun's Altitude on that Plane.

'From whence it follows that the whole A-'ction of the Rays, upon a Plane, is as the 'Square of the Sine of the Sun's Altitude on the 'Plane, and the time that Action laſts, joyntly: 'neglecting the Effects of the Atmoſphere.

'Let now the whole perpendicular Force of 'the Sun, upon a Plane directly expoſed to it, be 'expreſſed by the Radius CE, which is Unity 'divided into 10000 parts. The Force of the "Sun at the Meridian in T upon the Wall Ci, "will be as the Square of the Sine TI; that is, "ſuppoſing ſtill CE for Unity, as the Line TV "equal to 8410 parts; which I take upon the "Cylindrical Surface Northward. Now from "the Vertex I, upon the Axis IP, I draw thrô "the Point V the Parabola INV. And the Lines "or Ordinates as TV, MN &c, drawn parallel to "the Axis IP, from any Point as T or M in "the Line IT, till they meet the Parabola IV, "expreſs by their Lengths TV, MN the Action "of the Sun in the Tropick, in T or M &c, up-"on the Sloping Wall Ci. The Sum of all "thoſe Lines till Noon is the Cylindrical Surface "ITVI, which gives the whole Heat of the Morn-"ing Sun upon the Sloping Wall Ci, ſecluding, "as before, the Effects of the Atmoſphere.

"Now

"Now from the Point T drawing a Parallel "to the Horizon, till it meets with the Line C *m* M, "make the Line T L oppoſite to T V equal to "the Square of that Parallel; ſuppoſing ſtill "Unity to be expreſſed by C E. And in our Ex- "ample you will find T L equal to 2350 parts. "Draw the Parabola M L, of which M is the Ver- "tex, M T the Tangent at the Vertex, and L a "Point thrô which that Parabola paſſes. The "Ordinates, ſuch as T L, will give, for every cor- "reſpondent point of the Circle T M, the Action "of the Sun upon the perpendicular Wall C *m*. "And the Cylindrical Surface M T L M will give "the whole Heat of the morning Sun, upon that "perpendicular Wall, excepting only the Effects "of the Atmoſphere.

"Make the Point M the Vertex of another "Parabola, of which M T is the Tangent at the "Vertex, and V a point thrô which the ſaid Pa- "rabola paſſes. It is evident that the Cylindri- "cal Spaces M T V, M T L are to one another as T V "to T L, that is as 8410 to 2350, or as 3,58 "to 1. And that proportion obtaining for eve- "ry Point in the Arc M T, it is clear the Heats "ariſing from thence keep that very proportion "upon the Walls; notwithſtanding any variety "you may ſuppoſe in the Thickneſs and Effects "of the Air, thrô which the Light is to come "from different Altitudes.

But

"But there is yet all the Heat expreſſed by "the Cylindrical Surface MVI to be accounted "for.

"The Proportion between the Arcs TM, "TI will be found, by the help of their Verſed "Sines, to be as 100 to 127,6. And the Pro- "portion between the very ſmall Arcs *tm*, *ti* will "be found as 100 to 122½: which depends up- "on the Proportion of the Line TM to TI be- "ing as *tm* is to *ti*. And if upon TV you take "the Point τ, which is three times farther from "V than from T, and thrô that Point you con- "ceive the Circle τμι parallel to TMI, and meet- "ing the two Parabolas in μ and ι, you will find "the Proportion, between the Arcs τμ and τι, "as 100 to 124½.

"So then one cannot err ſenſibly with ſuppo- "ſing the whole Cylindrical Space MTVM to "the Cylindrical Space ITVI as 100 to 125, or "thereabouts; that is as 8410 to 10512; which "ſtands for the Cylindrical Space ITV, ſuppo- "ſing the Cylindrical Spaces MTL, MTV to be "2350 and 8410. And the Number 10512 "being divided by 2350, you find the Cylin- "drical Space MTL to the Cylindrical Space ITV "as 1 to 4,47. But this Number is to be ſome- "thing diminiſht, becauſe of the different Trans- "parency of the Air for different Altitudes. IMN "is very conſiderably leſs than the ⅘ of the Cy-

"lindrical Space I T V: and it is upon I M N, and "the neighbouring parts, that the greateſt Dimi-"nution of the Heat of the Sun dos fall. From "whence it appears that the ſaid Diminution can-"not be very great: Eſpecially, in our preſent In-"quiry, not the whole Diminution of the Sun's "Heat being to be accounted for; but the Di-"minution or Difference only from what the "Heat of the Sun is, when as high as in T.

The Reſult of it. However the Number 3,58 being certainly too ſmall, and the Number 4,47 certainly too great, to expreſs the whole Heat upon the Sloping Wall, it cannot but be pretty near 4 times as great as the Heat upon the perpendicular Wall: the middle Number between thoſe being 4,02.

This Method, which is clear and eaſie, is ſufficiently exact for our purpoſe: and it can be eaſily transfered to other Latitudes, and to the Caſes where the Wall is more or leſs ſloping: not to mention thoſe where the Wall has indifferently any other Expoſition.

Other Examples to the ſame purpoſe for the Latitudes of 51½; Thus if we leave the Latitude of 52½ Degrees, which is about the middle of *England* and *Holland*, and make the like Calculations for the Latitude of *London*, "L T will become 2204; "T V will remain 8410. The Space M T L will "be to the Space M T V as 2204 to 8410; or "as 1 to 3,82. The Arc τμ will be 47° 38'. "π is of 60 Degrees, as it was before. Now

"as

"as 47°38′ to 60°, so is 8410 to 10593, "which comes for the Space ITV. And dividing 10595 by 2204 the Quotient is 4,81; which is too great to express the Heat upon the Sloping Wall, as 3,82 is too little. The middle Number is 4,31, which was only 4,02 before. So here the Disproportion is considerably greater, between the Heat for the Sloping and the perpendicular Wall. On the Equinoctial Day the Heats are as 1000 to 614.

and 45 Degrees.

In the Latitude of 45 Degrees "TL becomes "1344, which gives MTL to MTV as 1 to 6,26. So the Heat is already 6¼ times greater for the Sloping than the Perpendicular Wall: besides the Addition of Heat MVL, which is very considerable. For the whole Space ITV is about 8¼ times bigger than MTL. The Middle between those two Numbers is 7¼. On the Equinoctial Day the Heat is exactly doubled. The immediate Action of the Sun upon the Walls, without any regard to the Heat reflected from the Ground, or occasioned by the Warmth of the Air, dos not become equal for both the Perpendicular and Sloping Wall, till the Sun has got a considerable South Latitude.

Sloping Walls are more necessary in colder Countries; but the Increase of Heat they give is greater in warmer Climates.

By this it appears that our Walls are not only good for the Climates of cold Countries, but that they will have the greatest Effect farther from the Poles. In *England* and *Holland*

land, and all the North, they are almoſt neceſſary; becauſe without them Fruits can hardly be very good. In *France* &c, they cannot fail of producing moſt excellent Fruits, of the Kinds that require a great deal of Heat, they being able there to outdo ſo much ordinary South Walls; than which confeſſedly there is among perpendicular Walls no hotter Expoſition.

Sloping South Wall paſſing thrô the Pole leſs hot, in the Solſtice, than the South Wall paſſing thrô the lower point of the Polar Circle.

Hitherto I have not compared Sloping and Perpendicular South Walls to the beſt Advantage of the former. For in our firſt Latitude of 52½ if the Sloping Wall was at Noon expoſed directly to the Sun in the Tropick, there would already be above 4½ times the Heat "from the "Compariſon of the two oppoſite Parabolas. Beſides that Addition I have ſo often mentioned, which would make the Heat about 6½ times greater, were it not for the Interpoſition of the Atmoſphere. The middle Number is 5½ or thereabouts. In the Equinox the Proportion of Heats would be found as 1000 to 748. So then a little loſs of Heat near the Equinox is here very largely made up about the Solſtice. And this may invite (inſtead of giving to the South Walls the ſame Elevation, as the Pole has above the Horizon) to give them rather a ſmaller Elevation by 15 or 20 Degrees.

If

If you desire a more accurate Method of comparing the Sun's Heat upon two different Walls, but with neglecting the Effects of the Air, you will have it in the Solution of the following Probleme; " which depends upon the Quadrature " and the Center of Gravity of the Line of " Sines.

A more accurate Method of comparing the Sun's Heat upon two plane Walls in any Situation. This Method depends upon the Quadrature and Center of Gravity of the Line of Sines and its Segments:

" The Latitude being given, for Instance that " of *London*, to find for a given Day, suppose that of the Summer Solstice, the Heat of " the Sun upon any Plane Wall whatsoever; " suppose a Sloping Wall that lies, for Instance, " North-East and North-West, and has an Ele- " vation of 48 Degrees upon the Horizon, " going obliquely from the North-East Point " towards he North. The great variety of Ca- " ses, into which this Problem may be branched, " obliges me thus to fix my Discourse, by apply- " ing it, in a great measure, to a particular Ex- " ample.

" Conceive, in the fifth Figure, the Sphere *Fig.* V. " POBDαβGAP, projected about the Center C, " for an Eye placed at an infinite Distance, in " the common Section of the Planes of the Slo- " ping Wall, and of the Equator, or its Paral- " lels. Let αχCNKA be the Plane of the Slo- " ping Wall; βχCEξB the Plane of the Equa- " tor; P the Pole of the World; DEZKHζχD " the Horizon; OTZNζG the Tropick or Parallel;

"lel; N the common Section of its Plane, with "the Plane of the Wall, whether this Section fall "within or without the Sphere; Z, ζ the two "Interſections of the Tropick or Parallel with the "Horizon, if they meet each other. In the Tri- "angle CKE the ſide EK being given, as here of "45 Degrees, and the Angle E being of 38½, "and the Angle K of 48 Degrees, you will ea- "ſily find the ſide EC and the Angle C. Take "upon the Equator C X equal to the Complement "of CE; and thrô the Point X conceive the Me- "ridian XHPTξX. In the Rectangular Trian- "gle EBD find BD; and ſo draw thrô the Point "E the Horizon DEZKHζxD, cutting, as I ſaid, "if it lights ſo, the Tropick or Parallel OG "in the Points Z, ζ; and draw the Indefinite "Lines ZY, ζυ perpendicular to OG. Take the "Radius of the Sphere for Unity; and make OV, "perpendicular to OG, equal to the Square of "the Sine of the Arc OA. From the Point N "as Vertex draw thrô the Point V the Parabo- "la NYVυ, making NO to be a Tangent at the "Vertex. Transfer as much of the Cylindrical *Fig.* VI. "Surface NVNON into the ſixth Figure, (where "it is opened, and the Parallel or Tropick be- "comes a ſtraight Line) as there is of it that is "ſeen from the Wall. And thus having drawn "from the Points Z, ζ duly transfered, if they "be ſeen by the Sloping Wall, the Ordinates ZY, ζυ,

"ζυ, the Space between them ZYVNZ, after it "is increaſed in the proportion of the Circum- "ference or Radius of the Tropick or Parallel "to the Circumference or Radius of the Equa- "tor, will give you the meaſure of the Heat up- "on the Sloping Wall. But this is with ne- "glecting the Effects of the Atmoſphere. Now "that Space, or a Solid proportional to it, is "found by having the Quadrature and Cen- "ter of Gravity of the Line of Sines, and of its "Segments; all which are already known. The "Truth of this Aſſertion is obvious without any "farther Demonſtration of it; and will appear to "agree with the following Conſtruction, which "alſo dos ſolve the Problem.

"To the Circle ONG, Fig. V. conceive the *Fig.* V. "correſpondent Line of Sines AOYBZGA Fig. VII. *Fig.* VII. "In which the Axis AB is equal to the Semi cir- "cumference, and the other Axis OG is equal to "the Diameter of the Parallel or Tropick. Thrô "the Point N duly transfered upon OG, to wit, "with making GN, GN equal in both Figures, "draw the Parallel NNN to the Axis AB, till it "meets in N, N with the Curve AOB continued "for that purpoſe as far as is neceſſary. And "having alſo duly trasfered the Point Z, by ta- "king the Line NZ equal to the Arc NZ, and ha- "ving drawn ZY perpendicular to NNN, and "meeting with the Line of Sines AOB in Y, up-

"on

" on NNZ as the Edge, and ZYOANZ as Basis, " erect a Semi-quadrantal Ungula; and find its " Solidity or bigness, by those Rules Dr. *Wallis* " has publisht in his Mechanicks; where he has " given the Quadrature and the Center of Gra- " vity of the Line of Sines and its Segments. " Then depress that Ungula, or make it smaller, " in the Proportion of the Square of NO to the " Square of the Sine of the Arc OA. When the " Solid of this new Ungula is found, correct it " again, increasing it in the Proportion of the Cir- " cumference or Radius of the Tropick or Pa- " rallel to the Circumference or Radius of the " Equator. The new resulting Solid will be " proportional to the Heat of the Sun upon the " Sloping Wall, if we neglect the Effects of the " Air.

" After the same way might be found the *Fig.* IV. " Solid expressing the Heat MTMLM of the IV. " Figure, upon a perpendicular South Wall; for *and is general:* " the Solution is general.

" But if the Cylindrical Surface MTMLM be *and in some few Cases* " also duly transfered into the VI. Figure, as *Fig.* VI. " you see it done; and upon the Basis MTM, *capable of a very easie Approximation;* " when it falls intire between the Points N, N, " you draw the Curve Line MAM, whose Or- " dinates upon MM are every where proportional " to the correspondent Ordinates of the Curve " MLM, and whose swelling comes just to touch " the

" the Curve NVN, the Heats expreſſed by the " Surfaces MLMM, MAMM will be as TL to TA, not- " withſtanding the Effects of the Air. Which " conſideration may be of ſome Uſe, where the " bigneſs of the remaining part is but ſmall, and " to be gueſſed at, as we did heretofore, by " ſome eaſie Approximation. But this by the " by.

notwithſtanding the Effects of the Air.

This Solution gives, as a Corollary, the Method of meaſuring the Heat of the Sun upon the Horizon, any Day in the Year, for any propoſed Climate; thô it remains yet to account for the Diminution of Heat ariſing from the Atmoſphere.

A Corollary for finding the Heat of the Sun upon a Plane, parallel to the Horizon.

I do not expect that the whole crowd of Geometers will ſee that our Conſtructions carry with themſelves the Strength and Evidence of a Demonſtration. But this Diſcourſe being intended to be, in a great meaſure, popular, I am loth to fill it with a long Digreſſion, only to make our Proofs evident to a greater number of Mathematicians. Let it be enough that ſome of them may perceive that we have advanced here nothing but what is exactly true.

Having calculated a Table of the Sun's Heat upon a Plane, for each Degree of the Sun's Elevation upon the ſaid Plane, I thought it might be acceptable to ſome if I tranſcribed it here. 'In 'this Table the Heats to an Elevation and to its

A Table ſhewing the Sun's Heat upon a Plane for each Degree of the Sun's Elevation upon it.

'Complement make always the ſame Sum: Which 'depends upon the Squares of the Sides being, in 'a Rectangular Triangle, equal to the Square of 'the Hypotenuſe.

The Sun's Elevation upon a Plane.	The Sun's Heat upon the Plane.	The Sun's Elevation upon a Plane.	The Sun's Heat upon the Plane.	The Sun's Elevation upon a Plane.	The Sun's Heat upon the Plane.
Deg.	Parts.	Deg.	Parts.	Deg.	Parts.
1	3	31	2653	61	7650
2	12	32	2808	62	7796
3	27	33	2966	63	7939
4	49	34	3127	64	8078
5	76	35	3290	65	8214
6	109	36	3455	66	8346
7	149	37	3622	67	8473
8	194	38	3790	68	8597
9	245	39	3960	69	8716
10	302	40	4132	70	8830
11	364	41	4304	71	8940
12	432	42	4477	72	9045
13	506	43	4651	73	9145
14	585	44	4825	74	9240
15	670	45	5000	75	9330
16	760	46	5175	76	9415
17	855	47	5349	77	9494
18	955	48	5523	78	9568
19	1060	49	5696	79	9636
20	1170	50	5868	80	9698
21	1284	51	6040	81	9755
22	1403	52	6210	82	9806
23	1527	53	6378	83	9851
24	1654	54	6545	84	9891
25	1786	45	6710	85	9924
26	1922	56	6873	86	9951
27	2061	57	7034	87	9973
28	2204	58	7192	88	9988
29	2350	59	7347	89	9997
30	2500	60	7500	90	10000
Degrees.	Squares of their Sines.	Degrees.	Squares of their Sines.	Degrees.	Squares of their Sines

If

'If the Sun's Altitude be given, and you ex- *The Use of the Table.*
'poſe to its Rays a Plane, with more or leſs O-
'bliquity; the Sun's Heat upon it will be, in
'any Obliquity, as the Table ſhews. But if the
'Sun's Altitude be ſuppoſed to change, the Ef-
'fects of the Atmoſphere ought alſo to come un-
'der conſideration. I need not ſay that I make
'no allowance for the Sun's apparent Diameter
'being of a pretty great bigneſs, and not inſen-
'ſible like the Stars.

As to the Diminution of the Sun's Heat, oc- *The Diminution of Heat occaſioned by the Air is conſiderable;*
caſion'd by the Interpoſition of a greater or leſs
depth of Air, it is certainly very great. We
cannot bear the Sight of the Sun when it is ſome-
thing high; much leſs if it was in the very Zenith.
But it is no hard matter to bear it, when the Sun
is within three or four Degrees of the Horizon.
It is not eaſie to find by bare Study the Laws *but hardly to be found by Meditation; and why.*
of that Diminution; 'not only becauſe of the
'different Denſity and continual Refraction of the
'Air, at ſeveral Heights from the Center of the
'Earth; but eſpecially becauſe of that wonderful
'Propriety of Light, that makes it go thrô, and a-
'mong Terreſtrial Bodies, under a certain and
'determinate Degree of ſmallneſs, depending up-
'on their Denſity, without being affected at *A Method for finding it by ſome Experiments with a burning Speculum.*
'all in its Paſſage. However I ſee how that
Diminution might be found, by ſome Experi-
ments made with a large burning Speculum con-

ſtantly turned to the Sun for a whole Summer-Day, and with a Thermometer kept by it always at the ſame degree of Heat.

'The middle of the Speculum muſt be ſhaded 'by a round Plate, ſupported exactly over againſt 'it. In the Shade of this Plate, and not far 'from the Focus of the Speculum, the Thermo-'meter, which ought to be but ſmall, muſt be 'duly faſtened. The Speculum ought to have a 'graduated Circle about it. And by the diffe-'rent opening of an Arched Ruler, that is to 'move about the Center of the Speculum, and 'to be every where pretty near its Surface, it 'ought to have an Opaque Vail ſpread, more 'or leſs, before it: So that a greater or ſmaller 'Sectour be uncovered, according as the ſtrength 'of the Sun's Heat requires. That Heat will be 'reciprocal to the Arc or Sectour uncovered. 'So then keeping, in one of the longeſt Days, a 'Table of the Quantity of this Arc, for the ſe-'veral Minutes, or other Intervals of Time, of 'which the Day is compoſed, one may eaſily 'gather the Proportion of the Sun's Heat it-ſelf, 'ſuch as is tranſmitted thrô the Atmoſphere.

A Table giving the Length of a Beam of Light in the Air, ſuppoſing the Height of the Atmoſphere given, &c.

'The following Table, which is very ſhort 'and eaſie to make, or, inſtead of it, ſome 'other Table made upon the like Princi-'ples, might help us alſo to gueſs a little, in 'ſo dark an Inquiry. This Table gives, upon

ſome

" some Suppositions, the Length of the Way of " the Sun-Beams thrô the Air, to every appa- " rent Altitude of the Sun.

Apparent Altitude of the Sun.	Length of the Way of the Sun-Beams thrô the Air.
Deg. Min	Parts.
0. 0	20.
0. 18	19.
0. 37	18.
0. 57	17.
1. 18	16.
1. 41	15.
2. 6	14.
2. 33½	13.
3. 4	12.
3. 39	11.
4. 19	10.
5. 6	9.
6. 3	8.
7. 13	7.
8. 45	6.
10. 51	5.
13. 55	4
19. 4	3
29. 45	2
31. 31	1 L 9
33. 32	1 L 8
35. 51	1 L 7
38. 30	1 L 6
31. 39	1 L 5
45. 26	1 L 4
50. 9	1 L 3
56. 21	1 L 2
65. 19	1 L 1
90. 0	1.

" Let $2r$ be the Diame- " ter of the Earth, equal, " for instance, to 400 " Parts: a the Perpendi- " cular Height of the Air " that is able to obstruct " sensibly the Light of " the Sun: this I sup- " pose, for an Example, " equal to 1 Part. Let the " Indeterminate q be the " Length of the Way of " the Sun-Beams thrô that " Air: s the Sine of the " Sun's Apparent Alti- " tude to the Radius r: " and neglect the Effects " of Refraction. In these " Suppositions you will " find $\frac{aa + 2ar - qq}{2q} = s$. " Which Equation is the " Ground, upon which " the Table was calcula- " ted. And if you give " any other Value to the Quan-

" Quantity *a*, you will easily make such another " Table, at your pleasure, by the help of the " same Equation.

How to find in an Air of an uniform Density the Diminution of Heat for the several Altitudes of the Sun.

' If we suppose the Air every where of an ' Uniform Density; and its Perpendicular Height ' given; which will be easily determined in that ' Supposition: and the whole Refraction of the ' Rays of Light to be, at their coming into the ' Atmosphere: and that the same Quantity of ' Light penetrates into the Air, whether it comes ' with more, or with less Obliquity; it will be ' easie to make a Table shewing the loss of Light ' occasioned by the Air, for any given Apparent ' Altitude of the Sun. And this may, perhaps, ' serve well enough for Use.

" From Experience find the Proportion of " Light, suppose as *a* to *b*, for any two Appa- " rent Altitudes of the Sun; suppose 62 and 30 " Degrees. Let the Length of the Rays in the " Air for those Apparent Altitudes be as *n* to *m*.

Fig. VIII. " Draw, in the eighth Figure, the Assymptote O A B, " of an Indefinite Length. Take in it O B equal " to *m*; O A equal to *n*; and A B will be equal to " *m*—*n*. Draw to the Assymptote the perpendicu- " lar Lines A D, B C, equal respectively to *a* and *b*. " Thrô the Points C and D draw the Logarith- " mic Line F C D Q: and draw the Ordinate O Q. " If you suppose O Q for the whole Light, that " enters the Atmosphere; and, upon the Assym-

" ptote,

" ptote, you take, from the Point o, the Line " o E equal to the Length of the Rays of Light " in the Air; the correſpondent Ordinate E F " will give the Quantity of Light remaining, af- " ter the Paſſage thrô ſo much Air, as the Length " of the Rays dos expoſe: And a Table of its " Diminution will eaſily be calculated. The " Ground, I proceed upon, is that if two Solid " Rays of Light paſs, thrô a given Thickneſs of " Air equally denſe, they will loſe of their Quan- " tity, or Strength, in the ſame Proportion, as " they have to one another. By the like Me- " thod you may find how much more Light there " is, at any time, near the Surface of a Calm " Water, than in any given Depth. ' And this ' is what we had to ſay of the Diminution of ' Heat, occaſioned by the Rays of Light croſſing ' the Atmoſphere. Let us now take our leave of theſe Mathematical Speculations, and go on to conſider what Advantage we can make of Movable Walls.

As there are ſome Countries, or ſome ſorts of Fruits, for which the beſt is not always the hotteſt Expoſition; ſo there are ſome other Countries, or ſome other ſorts of Fruits, for which we cannot well procure too much Heat. But it will be a hard matter to outdo much the South Walls of our ſecond, or third, or eleventh Figure; of which laſt I ſhall ſpeak hereafter; unleſs it be per-

Of Movable Walls, in order to receive the Light of the Sun almost perpendicularly for the whole Day.

perhaps by a Movable Wall. I shall not mention here the placing some Earth, and having a Sloping Wall built, all along in a kind of Boat; or otherwise built, in any other sort of floating Vessel; as suppose a round one. Thô with the turning of the Vessel, so as to follow the Sun, and making it, and the Wall at the same time, lean more or less, one might be sure to injoy almost all the Sun's Heat. I will only describe a kind of movable Box, which having an Inclined Brick Wall fastened to it, will, without any Water, which both is difficult to procure, and rots Vessels too easily, have the same advantage of being constantly turned towards the Sun; and may, in Winter time, be laid up in an Orange House.

Description of an Engine for that purpose.

Fig. IX. X.

'In the IX and X Figures A B is a strong 'Post fastened upright in the Ground; whose 'upper end B is shaped into an Hemisphere, 'or rather into a Part of a Sphere, yet something 'bigger. Upon B there rests a strong piece of 'Oak, C C; in the middle of which there is a 'concave Place, so made as to fit the Figure of 'B, and to leave the liberty of turning and in-'clining the Box several Degrees to and fro. The 'concave Surface will be great enough, if it con-'tains the half of the Surface of an Hemisphere. 'D is the Box it self; which is somewhat long, 'and so shaped that the Sun may shine pretty 'fully upon the foreside of it. To the two sides

of

'of the Box, and to the Piece C C, are fastened 'two inclined Pieces of Timber E F, E F, almost 'parallel to one another; and upon these, close 'by the Box, another pretty long horizontal 'Piece of Timber G G. The remaining Pieces 'G F, G F; G F, G F; F F; E G, E G; E E, are so disposed as 'to give much Strength to the whole Frame. Up-'on the Part G F F G I place a Floor of Boards, 'and the Piece G G jets out some two or four In-'ches, from that Floor. I use both the Piece 'G G, and the Floor of Boards, for the Founda-'tion of my inclined Brick Wall; to which I 'give a thickness equal to once or twice the thick-'ness of a Brick, according to the Weight as I 'desire it should have. Under the Box are yet 'two strong parallel Pieces of Timber H H, run-'ning on each side close by the Post A B; and 'made firm together, at both their Ends, by two 'cross Pieces. From the back End of H H there 'rises several Pieces H K, H I; which being fasten-'ed to the Pieces E F, some near the Middle, some 'at or near the upper End of the Floor or Frame, 'help to bear it up. In the Pieces H H there might 'be some holes, at proper distances from each o-'ther, for two Iron Pegs, one of each side the 'Post A B, to keep, at your pleasure, the whole 'Box in a proper Elevation. But this might be 'done more conveniently with Cords. For from 'the Ends E, E; F, F; G, G; H, H, you might have some

'Cords fastened to some pretty great Weights of 'Metal or Stone, or else to some Buckles, to 'keep the whole Engine firm in any position. 'In the making of it it must be so proportioned, 'in all its Parts, that the Center of Gravity may 'fall under B, but withal near it. And so it will 'be proper that the Floor be not exactly flat, 'but convex. The Addition of some movable 'Weight like P might also help to alter the Cen-'ter of Gravity, and to manage the Engine more 'easily. And it is to be observed, that the far-'ther c c is from the Box, the wider you may 'make it at bottom. Such an Engine as this will easily be defended from Ants and other creeping Insects. 'About the Floor G F F G one might have 'a kind of plain Border, with an Inclination to 'the Floor, of about 45 Degrees every where: 'which Border, by its Reflexion, would much 'increase the Heat, and make it closer; giving 'besides some Shelter from Winds: And upon it 'one might spread a Net, to keep off the Birds 'and Flys.

If, by an easie change, you should desire to have two Boxes and two Trees, in one single Engine, the Boxes being something distant from each other, there would be room for the Post A B between them; and you might make them as broad as you would at Bottom; and fix the bearing Place much lower, if you thought it con-

convenient ſo. Inſtead of Bricks the Floor might perhaps be covered with Lead, either painted dark or black, or not painted at all. But I am apt to think it would give, in ſome Climates not far from this, and at ſome Seaſons in the Year, too great a Heat for Vines, and ſuch other tender Trees.

Advantage of movable Walls againſt ſtorms and winds.

One advantage of Movable Walls is that they may, at any time, be turned from Storms, and from cold or blaſting Winds; and take in as much, or as little, of the Sun-ſhine, as one pleaſes. They might beſides, when the Sun is ſtrong, and the Fruit grown large, be ſometimes preſented ſide ways to the Sun, that it may ſhine fully upon the Sides of the Fruits; and give them alſo that fine Colour which becomes the whole Fruit ſo well. But after all theſe Walls may better ſerve the turn of ſome Curious Body, than the Publick. They will be good particularly for Melons, Vines, Figs &c, and for raiſing early moſt ſorts of Fruits.

Their Uſe for early Fruits.

Of the Rain falling upon Sloping Walls.

As to our former Sloping Walls, it remains yet to order them ſo that we may not be troubled with the Rain, they are apt to bring in abundance to the Root of our Trees. But this certainly can be no fault in a dry Seaſon, or light Ground, or Eaſterly Wall, or hot Countrey; eſpecially conſidering the great force of the Sun upon our Terraſſes, which will quick-

ly dry the Ground. In other places, beſides what may be done, by receiving and turning off the Rain, the Walk might be made as you ſee in Fig. XI. the XI*th* Figure; where it is pretty deep in the middle of it. ' is the Slope of the South

Terraſſes ſo ſhaped as to give ſome more Advantages in reference to Rain and Heat.

'Wall; AM the Cultivated Ground, ſome three, 'four, or five Foot broad: MN another thin 'Sloping Wall, parallel to BA, and ſome three 'or four Foot high: NO the Walk, or Path; 'which may be five or ſix Foot broad, and pa-'ved, if you think fit. OP, PE, EG are the cor-'reſpondent Sloping North Walls and Cultiva-'ted Ground. The great Depth of NO will keep 'the Grounds AMN, EPO pretty dry: and the 'Path NO may be made falling, in order to 'bring the Water to ſome Drains, where it may 'be loſt. In an extraordinary wet Weather, one 'might uſe ſome ſlight Boards, like QR, and 'place them ſo, near the Foot of the Sloping 'Wall, that they might receive the Rain at 'their upper end, in order to convey it to the 'bottom NO. For this purpoſe it is proper that 'there be a very ſmall jetting out in the Wall, 'to which the Boards may be cloſely applyed. 'Or rather one might, at firſt, fix in the Wall a 'long and narrow piece of beaten Lead, which 'neceſſarily receiving the Rain, would eaſily 'bring it to the upper Surface of the Boards, or 'to ſome Gutters placed along the Wall, which

'would

'would be much convenienter than the Boards; 'and would easily convey the Water to some o-'ther Gutters that should make it fall upon the 'Bottom NO. The Slope MN, receiving so 'directly the Sun-shine upon it, will help ve-'ry much to heat the Ground NMA; and by 'consequence will, in some measure, forward 'Vegetation. The Bottom NO, which is to serve 'for a Path or Walk, must be raising near the 'middle in a round Figure, to keep it dry there. The two Terrasses being farther from one another, than in the second or third Figure, the Heat will accordingly be less close.

Now we have begun to propose, for our Terrasses, a Shape something different from that excellent one, in the second and third Figure; we may farther observe that there would perhaps be some small Advantage to shape our cultivated Ground so as to have it better exposed to the Sun, and grow warmer. 'We might, for Instance, 'let the Section of our Walk, in the eleventh 'Figure, be according to the Lines BRMN-OTEG; 'and order matters so, as not to be troubled 'with the Rain, especially in the Ridge E. And 'by these means we should also get a Sloping 'Wall OT, of a tolerable bigness, and very 'well sheltered, but ill placed, and of an indif-'ferent Exposition.

You

You may remember how, ſpeaking to the firſt Figure, I did chuſe, in the ſide of a narrow Vale, a pretty ſteep Hill well expoſed; which I did ſhape into ſeveral Terraſſes, one above another. I don't know but that, keeping to the like Idea, it may ſucceed pretty well, eſpecially about 45 Degrees Latitude, to chuſe that Hill very ſteep, to take it almoſt as Nature dos give it us, and to pave it all over with Brick laid flat, except ſome Holes of an Oval Figure, about ſix or ſeven Foot long, and about four Foot broad. Theſe Holes are each to receive at the Top of them a Tree, whoſe Branches muſt be made to ſpread upon the paving of Bricks. The greateſt Diameter of the Ovals ought to be horizontal. They muſt be diſpoſed with as much regularity as poſſible. They will look handſomer, and will be more equally divided, and lie more convenient for the ſpreading of the Tree, and to receive all the Rain, if they be Checker-wiſe; as you ſee them in the twelth Figure. But they will lie ſomething more conveniently to turn off the Rain, if they be above one another. However it ſeems there is no great danger to be feared, from too much Rain, in a Hill ſo well expoſed to the Sun; and where an extraordinary quantity of Rain will not fail to find its way down, or will ever be eaſily turned off. The uncovered

Idea of a paved ſloping Ground upon a Hill, to be uſed inſtead of Terraſſes with Sloping Walls.

Fig. XII.

ed Earth must be dug as often, as it is convenient. The Bricks will grow very hot, by the Sun shining so fully upon them: And, for ought I know, they may hinder the too great and useless Dissipation of the Spirits of the Earth, that secret and precious Fire of Nature, not only by preventing the growth of Grass, but also by intercepting their way, and making them come out, in greater abundance, at the place where the Trees and their Roots are. The good Earth must have been gathered to a sufficient Depth about the Ovals. It is easie to order it so that either all the Rain shall run into the Ovals, or most of it run down at the sides of them, according as your Climate or the Season requires. As to the Charge, both in Bricks and Mortar and Day-labour, it will come, for each Tree, to much less than half the correspondent Charge, in building of a perpendicular Wall; thô we should suppose this to have Trees on both sides.

It will prevent the dissipation of the Spirits of the Earth.

Since I began this Treatise, I have often inquired whether our Sloping Walls had been used any where: And particularly I have indeavoured to find, in Monsieur *la Quintinye*'s Book, what he says that may relate to this matter. It is very plain that they are in no common use, if used at all, in these Northern Climates, where they are most wanted. And probably

What the Author finds said by others, particularly by Monsieur la Quintinie, *that may have some relation to Sloping Walls.*

bably they have have had no occasion to think of them in hotter Climates, where, for the most part, Heat is as much feared, as here it is desired. But I would fain have known whether ever they had been designedly built, on purpose to injoy the Sun longer, and to increase its Heat.

Monsieur *la Quintinye* speaks * of some Sloping Grounds, which he calls *des Ados*. * These, * he says, are an Earth raised up, with a Slope, * along a well exposed Wall, in order to sow * upon it, in Winter time and in the Spring, * some Plants, that are designed to be more * forward, than in the open Ground. So Pease * and Beans are sown, and Artichokes, Vines, * Rasberries &c, are planted upon an *Ados*; the * Reflexion of the Sun, probably from the Wall * above, and from the Ground before, heating * these Slopes, as if they were real Walls. What I find said of them, in the rest of the Work, is much to the same purpose.

* Tom. I. p. 20. Edition of *Amsterdam*, 1692. *An Account of what Monsieur* la Quintinye *calls* des Ados.

By this contrivance, the Origine of which I do not at present inquire into, one dos considerably increase the Heat, at all times in the Year; and I do not see that one can out-do it much in Winter or Autumn. But, in the Spring and Summer, the Wall hides the Sun from the Slope for some time; which perhaps the Reflexion from the said Wall is not a sufficient

cient recompence for. To which must be added, that the Heat is perhaps better, being divided to a greater part of the Day, than crowded together about Noon. However by this Disposition of the Wall the Heat is made closer.

In another Place * he dos mend the hanging of the Ground, in a large Garden, but without admiring at all the Remedy, by dividing it into several Parts, of different heights, and making each of them level, and parting them, either by some little Walls, or only by some Slopes of Earth closely beaten together. And being satisfied, as he has it somewhere else, that there is no place, in a Garden, but what may be of some use; he says, * That these little Walls may * serve for several things he mentions: and that * the little Slopes will not be useless neither; but * on the contrary, when they are exposed to the * South or East, they may either be used to raise * at first some early Plants, for the Spring; as * Winter Lettuce, Pease, Beans, Strawberries, * Artichokes &c; and after the Spring they * may serve to raise some Seeds of Purslain, Basil &c: or else, if there be a great quantity of * those Slopes well exposed, a part of them may * be imployed for good and all to bring forth * good Grapes and other Fruits; as it has been * done in the King of *France*'s Fruit or Kitchen * Garden, in certain Slopes purposely made for * that use.

* Pag. 92. *And of his Slopes of Earth exposed to the South or East, and purposely made for Fruit.*

Reflexion upon this Contrivance;

I gueſs, by theſe Paſſages, that the worthy Author, who is ever very particular and full in what he writes, thô he ſays no more in this matter, uſed theſe Slopes no otherwiſe than as Grounds, and as they do chuſe ſome Hills well expoſed for their Vines, or even for their Gardens. But thô this be ſomething a-kin to the main Idea I follow, in this Diſcourſe, and a Confirmation of it, yet I believe there remain ſome conſiderable differences, between what Monſieur *La Quintinye* has writ, and what I propoſe. The Gardens of his making may juſtifie whether or no he had left any room for our Meditations. Which would indeed be only a fuller Explication of his Thoughts, if he had covered his Slopes with Bricks or Stones; and had made his Trees to grow againſt them obliquely to the Ground; and had uſed them in any Expoſition rather than perpendicular Walls; and had made them ſometimes more, ſometimes leſs Sloping; and had defended them, as I do, againſt Winds; and had likewiſe procured the cloſeneſs of Air, with no loſs of either Sun or Rain, for the ſix or ſeven hotteſt Months, from Equinox to Equinox: Not to mention ſome other Improvements you will find in this Treatiſe. However thoſe Ados of Earth have a peculiar advantage for all Herbs; and particularly for thoſe early Plants, that are to be gathered in *February*, *March*, or *April*.

which is here compared with Sloping Walls.

To

To this I might add the Account Monſieur *La Quintinye* gives of Square or Rectangular Gardens; where he explains how the Sun never ſhines upon more than two Walls at once; and in ſome Moments upon one only; without ever ſhining upon two oppoſite Walls together. But near the Summer Solſtice one might ſee, for a good while together about Noon, the Sun to ſhine at once pretty full upon the four Walls of a Rectangular Garden built after our way: and ſeldom, in the reſt of the Day, to ſhine upon leſs than three Walls, except the Sun be very low.

Part I. pag. 205.

Our Gardens, thô ſquare, may at once injoy the Sun upon their four Walls.

There is in Monſieur *La Quintinye*'s Book a Ground Plat of the Kitchen Garden, or Fruit Garden, of *Verſailles*. Thô there be in that Garden a high and very long Terraſſe, with Trees on both ſides againſt it, yet the Ground Plat ſhews that the Walls of it are perpendicular. So this Terraſſe having at once the diſadvantages of being more chargeable, and leſs ſolid or laſting, and worſe for Vegetation than a Terraſſe with Sloping Walls would be, I cannot but conclude alſo from thence that Monſieur *La Quintinye* knew no other Walls than perpendicular ones. As to the Beauty, I acknowledge indeed our Sloping Walls not to be altogether ſo handſome as the others are: And yet I do not doubt but the Eye will ſoon be accuſtomed to them; eſpecial-

In Monſieur La Quintinei*'s Ground Plat of the French King's Garden no footſtep found of Sloping Walls.*

To what degree they may be unpleaſant to the Eye.

ly when it may look upon them more as Terrasses, than as Walls; so that their leaning may not seem to threaten a fall.

Objection from Monsieur la Quintinye's *English Translation solved.*

In the English Translation of Monsieur *La Quintinye*, I find a place, that seems peremptorily to condemn our Sloping Walls. It is near the end of the fifth Chapter of the third Part of the first Volume. There you may read, * By * all I have newly said, about the Height of * Walls, it appears that I have little value for * those leaning Walls, to pretend to make them * Fruit Walls for Pears, Peaches, Apricocks &c; * but they may serve for something else. And in the Margin you find also writ, * Leaning * Walls not proper. But the Sense, in the French Original, is that such Walls as are only breast high (*des Murs d'appui*) are not good for Fruit. Neither was the Author speaking of Sloping Walls before, but of the Height of perpendicular Walls.

Account of an Amphitheater with Sloping Walls.

I have also heard of a large round Pit, like an Amphitheater, built here in *England* with Sloping Walls all about it. The Ground in the middle was, as they said, several Yards Diameter, perhaps about 50 or 100 or more. And upon all that Ground there grew Vines, both sheltered from Winds, and cherished with a closer Heat, than they could have in the open Air.

A Person of Quality has tryed about, 53 Degrees Latitude, in the present Year 1697, to increase the Sun's Heat upon his Melons, by some pretty large Convex Glasses. These being placed, between the Sun and the Melons, did gather the Rays in a pretty small Focus each. And we have been told, to our admiration, that the Melons thus helpt have been tolerably good, and much better than others that did grow in the Neighbourhood, which were generally bad ones. As if it were enough to heat any one part of the Fruit, to make the Effects of it to spread over the whole. But I hear also that the like Tryals having been made upon several Fruits, in other places, have had no other success than the giving them some unkindly precocity, leaving withal to them a harsh and unpleasant taste.

And of some Melons, and other Fruits, heated with Convex Glasses.

In some places, they make a Vine to grow as high as the Roof of some ordinary Building; and there to spread its Branches over the whole Roof. In other places, they make the Vines to grow first as high as the top of a Garden Wall; and there to part into two Branches, running on each side, for 25 or 30 Foot together, upon the small Coping of Bricks, they do sometimes end their Garden Walls withal. Thô I have been told that, with the first of these two ways, they have had some good Grapes in *England*; yet I find,

The fault of Vines that are commonly made to grow against a Roof, or the Coping of a Wall.

find, in both of them, this capital fault, that the Roots having work enough to feed so long a Stock, and to garnish such a large extent with Leaves, and a thousand other little useless Shoots, there can remain no strength in the Sap, for the production of Grapes; unless perhaps they be some few and ill favoured ones.

Judgement of those and all other such Trials, in order to make the most of the Sun's Heat.

All these and the like Trials were indeavours towards what is here more fully stated: for I do not doubt but a great deal more besides has been attempted, in many places, in order to make the most of the Sun's Heat. Whether I have done any thing more towards it than others, let either Experience justifie, or those determine, that are able to understand the Mathematical part of this Discourse. But after all I acknowledge readily that our Invention required but an ordinary Capacity, to light upon it; and even but an indifferent Skill in Geometry, to examine and establish it upon its true Principles.

Caution against too much Heat Sloping Walls are like to procure.

I must here repeat again and again, that I have, in this Discourse, indeavoured to increase the Sun's Heat to an extraordinary degree: and this, I hope, I have found how to do effectually. But it is easie in hot Climates, and in some light and dry Grounds, and in the governing of tender Plants, to err by an excess of Heat. If any body should fall into that Errour, it must be by his own fault. He may take as much and

as

as little, as he pleaſes, of that degree of Heat, which is to be had by our Sloping Walls. Thô accommodating my ſelf to the Climate of *England*, where too much Heat is hardly to be feared, I may perhaps have ſometimes ſpoke, as if one were always to take the moſt. However a pretty good Remedy, againſt too much Heat, is to keep conſtantly the Ground ſufficiently watered: So that the Trees being conveniently full of moiſture, their Fruits may be ſo much the farther from being ſcorched and dryed up. And here I may obſerve by the by, that if our Terraſſes be ſo broad as to have, at the top of them, a little Rivulet, or Aqueduct, it will be very eaſie from thence to water them on both ſides. But this is perhaps above the Circumſtances of an ordinary Gentleman's Eſtate. The ſame conveniency for watering would be found, in the ſteep Hill of the twelfth Figure, provided there were ſome Water at hand, above the uppermoſt Ovals. *Fig.* XII.

If you have a Sloping Wall ready built, and you are unwilling to have all the Heat it dos give, you may keep your Trees upon ſome Frames or Eſpaliers, at ſome little diſtance from the Wall, as half a Foot, or a Foot, or a Foot and a half, more or leſs, as you intend to take off more or leſs of the Sun's Heat. Thoſe Frames, thô not much uſed in *England*, are yet better. *Frames called* Eſpaliers *by the French recommended, to take off ſome of the Sun's Heat, and to give more liberty to Trees.*

ter than the bare Wall, becauſe they leave more room and liberty to Trees.

A Method for chuſing the Elevation of a Sloping Wall, in any Expoſition whatſoever.

Perhaps you may deſire to have ſome Method, for the chuſing of the Elevations of your Walls, when they have any other Expoſition than to the South, or to the North. I do for this make uſe, in our Climates, of the following Conſtruction; 'which I do not give as 'a Geometrical one, but only as a Mechani-'cal Approximation, for the Solution of a 'Problem perhaps too hard, to be ſolved, in its 'full Extent, with any great exactneſs.

'An Expoſition being given, in a given Cli-'mate, it is eaſily underſtood, by what I ſaid be-'fore, that all Fruits do not require the Sloping 'Wall ſhould have the ſame Elevation: but that 'ſome Fruits will have it great, ſome little: and 'that among theſe Elevations there is two Ex-'treams, to wit, the higheſt Elevation and the 'loweſt, that ſtand, as it were, for Limits of the 'reſt. I call the higheſt Elevation, the Sloping 'Wall can have, in the given Expoſition, ſimply 'the greateſt or higheſt Elevation; and its pro-'per Wall the higheſt Wall. And I call the 'loweſt Elevation, the ſame Wall can have, in 'the ſame Expoſition, the ſmalleſt or leaſt Ele-'vation; and its proper Wall the loweſt 'Wall.

'Let

'Let H A be the Horizon, A O P the Meridian; *Fig.* XIII.
'A O an Arc equal to the Elevation you chuſe
'to give to your Sloping Wall, when it looks
'to the North: A P the Height of the Pole. And
'you may find thus the greateſt Elevation of
'your Declining Wall; whether it declines
'to the Eaſt, or to the Weſt. Draw the Line
'P O, whoſe middle is D; and determine how
'much more you would take, for the greateſt
'Elevation of your Eaſt Wall, than for the
'greateſt Elevation of your Weſt Wall. For I
'do chuſe to give the Eaſt Wall a greater Ele-
'vation, that it may injoy the Morning Sun
'more fully: and to the Weſt Wall a ſmaller
'Elevation; that the Sun may come the ſooner
'to ſhine upon it. Suppoſe, for inſtance, you
'chuſe 5 Degrees, or 10 Degrees, for the dif-
'ference of Elevations, between the higheſt Eaſt
'Wall, and the higheſt Weſt Wall. Place thoſe
'10 Degrees, for inſtance, in the middle of the
'Arc P O, from S to T; and let S be higher than
'T. And draw the Lines D S, D T. Make the
'little Circle P D O to ſerve as a Compaſs; where
'the Point O will anſwer to the North Expoſiti-
'on, and the Point P to the South Expoſition.
'Let your propoſed Expoſitions look, for in-
'ſtance, towards the 60th Degree, taken on both
'ſides the North: and upon the Circle O D P
'take O E equal to 60 Degrees. The Lines E σ,

'E τ, parallel to D S, D T, will give, upon the 'Arc A P, the greateſt Elevations A σ, A τ, for 'the two Walls: to wit, A σ for the Wall that 'looks 60 Degrees Eaſt-ward, from the North 'Point of the Horizon; and A τ for the Wall 'that looks 60 Degrees Weſtward, from the ſame 'Point.

'The ſmalleſt Elevations, belonging to the 'ſame Expoſitions, will be found with taking A Q 'equal to the ſmalleſt Elevation of the South 'Wall, and proceeding, with the little Circle 'O Q, as was done, with the little Circle O P. 'Now the Point Q cannot be lower than the 'Point O. For whatever be the leaſt Elevation 'you can give to the South Wall, the North 'Wall requires either the ſame, or a lower: 'and never the ſame, but when it ſeems incon- 'venient, for Vegetation, to give a lower.

'If the Point Q happens to be very near the 'Point as ſuppoſe within 5 Degrees from it; 'you may, upon the little Circle O Q, take O e 'of 60 Degrees, as before; and draw to O Q 'the perpendicular e b, meeting with the Arc A P 'in b; and ſo you will have the Arc A b, for the 'leaſt Elevation. And, if you think fit, you 'may add to and ſubſtract a little from it, 'at your pleaſure; if you intend to give more 'Elevation to the Eaſt Wall, than to the Weſter- 'ly. But let it be ſo that you may ſtill remain,

'be-

'between the Limits o, o. However much Nice-
'neſs, in ſo wide a Conſtruction, is probably
'ſuperfluous.

The Heat remains ſenſibly the ſame, for the South Wall, and for the North Wall too, if, keeping their Elevation each, they are made to decline ſome few Degrees, from the North or from the South. 'This is partly plain, becauſe 'the Heat, upon a Wall, whoſe Elevation is 'given, is a *Maximum*, when the Expoſition 'is to the South, and a *Minimum*, when it is 'to the North. And, this not being a ſuffici-'ent Proof, it is alſo further evident, by ſome 'Calculations, which I forbear to inſert here.

The Heat ſenſibly the ſame, upon a South or upon a North Sloping Wall, thô a little declining from the true North or South.

"For thô a *Maximum*, or a *Minimum*, dos not, "for the moſt part, alter its bigneſs ſenſibly, when "the Elements, from which it reſults, are but "a little changed; yet it happens ſometimes, as "in the Points of Retrogreſſion of Curves, that "a *Maximum*, or a *Minimum* will alter very much, "upon the leaſt change in its Elements; as "ſuppoſe in the Abſciſſe. And not only a *Maxi-*"*mum*, or *Minimum*, may be found, where the "Fluxions of the Abſciſſe and Ordinate are ei-"ther of them infinitely greater than the other; "but where thoſe very Fluxions have any de-"terminate and finite Proportion among them-"ſelves. But a part of this has already been "obſerved by others.

A ſingular ſort of Maximums *and* Minimums, *very different from thoſe that are commonly conſidered.*

The ſame, in ſome meaſure, already obſerved by others.

The Ground of the foregoing Method.

This Equality of Heat is the Ground of the Conſtruction I have given, for determining the Elevation of declining Walls. For it follows eaſily from it, that the Elevation of the South Wall will remain ſenſibly the ſame, thô it declines, ſome few Degrees, from the true South; and that the Elevation of the North Wall will alſo remain ſenſibly the ſame, thô it ſhould decline, ſome few Degrees, from the true North.

Experience muſt alſo be conſulted.

But Experience will be, in all Climates, the propereſt way to determine, for each Fruit, and each Expoſition and Situation, and each ſort of Materials, our Walls may be made withal, the Elevation that ſhould be given to Sloping Walls.

Of Walls that are not ſmooth.

We muſt now compare, as well as we can, a ſmooth and plane Wall, with a rough irregular Wall, and with ſome other Walls, that are not plane.

There can be no ſuch thing as a Wall giving the Heat proportional to the Sine of the Sun's Elevation upon it.

In this Theory I have ſuppoſed hitherto the Walls to be very ſmooth and plane. 'And in 'that Suppoſition the Heat is as the Square of 'the Sine of the Sun's Elevation, upon the Plane 'of the Wall. But, if it was poſſible to have 'a Wall, of an uniform and determinate rough-'neſs every where, that could perpetually fold 'its rough Surface into larger and ſtraight priſma-'tical Furrows, ſo as to have always one ſide of 'the Furrows parallel to the Rays of Light, and 'the other ſide perpendicular to them, the Heat

'would

'would then be, and only then, as the Sine 'of the Sun's Elevation upon the Wall. Which 'must be so understood, as not to exclude a 'Wall, whose roughness vanishes into an exact 'Plane. I am apt to think that our ordinary 'Walls, thô very rough and uneven, come nearer 'the first Supposition, than the second. But, if 'the second was to take place, " TV, TL must, " in the fourth Figure, be made equal to the " Sines of their proper Arcs TP, TZ: And the " Parabolas MV, ML, IV, must be turned into " straight Lines, and the rest of 'the Calcula- 'tion must be altered accordingly. The result 'of which would be a much smaller disproper- 'tion of Heat than before, between the Sloping 'and the perpendicular Wall. But, notwith- 'standing this, there would be yet left a very con- 'siderable Increase of Heat for Sloping Walls; 'which would give a sufficient incouragement 'for the building of them: As will soon ap- 'pear to you, by an easie Calculation, too 'obvious after all I have said, for me to ex- 'plain it any farther. However it is not pos- 'sible that the Heat should follow this Propor- 'tion. " If the Heat was supposed as S ½, which " is the mean proportional, between the Heats " in the two former Suppositions, taking S for " the Sine of the Sun's Elevation upon the Wall; " then, TV, TL being duly determined, the Pa- " rabo-

But if there was, the [*Fig.* IV.] *Method of calculating the Heat upon it would be easie.*

And Sloping Walls would be yet very advantagious, even in that supposition; thô less than before.

Of a Wall giving a mean proportional Heat, between such a Wall as this and a Plane Wall.

" rabolas would be turned into Parabolas of a-
" nother Kind, where the Cube of the Ordinate
" would be as the Square of the Abſciſſe. And
" the Calculations woud be made after a Method
" like that I followed before. And the reſult
" would come much nearer my firſt Suppoſition:
" thô it would perhaps yet fall ſhort of the
" true Increaſe of Heat, upon the Wall.

A ſmooth Wall compared with a rough Wall.

A ſmooth South Wall ſeems to receive more Heat in all, than a rough irregular Wall. But the rough Wall receives more Heat, while the Sun ſhines very obliquely upon it, than a ſmooth South Wall would do: And it receives leſs Heat than the ſmooth Wall, when the Sun ſhines near full upon both. For my part I think the ſmooth Wall to be preferable; not only becauſe it ſeems to have more Heat in all, and looks much neater, but becauſe it gives no ſhelter to Inſects.

How to make a Brick Wall ſmooth.

The very ſloping of a Brick Wall will give an advantage for the poliſhing or making of it ſmooth, by the drawing to and fro of a rough and hard Stone ſufficiently plane upon it, the Stone being large and ſuſpended from above, to ſome convenient place for that purpoſe. But we have one ſort of very large and thin Bricks, whoſe Figure is an exact Square, already poliſhed to our Hands.

Neither ſhould I be very fond of a Sloping South Wall, with ſome ſmooth ſemi-cylindri-

cal

cal Furrows upon it, running from top to bottom, in all the Wall; as in Architecture ſome Pilaſters are often made; the flat part between the Furrows being alſo very ſmooth; unleſs the Furrows were very ſmall indeed; which would bring the Wall ſo much the nearer a Plane. Any other Furrows would prove too convenient a Neſt for Inſects. *Of a Sloping Wall with Semicylindrical Furrows upon it.*

'I have calculated, more 'out of Curioſity, than for any real Uſe, the 'Proportion of Heat, for an Equinoctial Day, 'upon ſuch a Furrow, and upon the Plane Wall, 'or Faſcia, that could fill it up to the very 'Axis; ſuppoſing the Atmoſphere not to act up-'on the Rays of Light, and the Elevation of 'the Walls to be the ſame, with that of the 'Pole; and theſe Walls to be turned directly 'to the South. And I have alſo calculated the 'Heat, that the like Faſcia would receive, if it 'was turned directly to the Sun, for the whole 'Day. *Theſe Furrows compared with a Plane Wall of the ſame breadth with them.*

"In the ſeventh Figure, where C is the Cen- *Fig.* VII.
"ter of the Lines of Sines OA, AG, make up the "Rectangles AD and GCAE; and upon the "Axis AC conceive the Solid formed by the "Revolution of the Space OAGO, as well as the "Cylinder formed by the Revolution of the "Space DEGOD. The Heat of the Sun, upon "the Faſcia always perpendicular to its Rays, "will be, at the Days end, as the Moment or

"Weight

"Weight of the Cylinder ODEG, in reference to "the Line OD; ſuppoſe as the Number 9870. "And the Heat upon the Cylindrical Surface, "will be as the Moment of the Solid OAG, in "reference to the Line DE; that is as 2723. "And the Heat upon the inclined Faſcia, will "be as the Moment of the Solid OAG, in "reference to the Line OD; that is as 2467.

"But the inclined Faſcia, or the Plane Wall, "receives, in proportion to its Surface, much "more Heat than the Semi-cylindrical Cavity; "as appears both by the very Numbers I have "juſt now given; and by taking upon the "Semi-cylindrical Surface a ſmall Space, equal "to the like Space upon the inclined Plane "Wall. For the Space, taken in the Cylindri-"cal Surface, will be ſeen by the Sun, only "for ſix Hours: And the moſt it can receive "of the Sun's Heat dos but equal the Heat, "that the Space taken in the Plane Wall dos "receive, from Nine in the Morning to Three "in the Afternoon. The Wall with the Cylin-drical Furrows has ſome Advantage, in that the Solid, between the Furrows, not being thick, it may be heated from ſide to ſide, and in that the Reflexion of the Sun-Beams makes the Heat ſomething cloſer. But the advantage will be greater if the Furrows be very cloſe, and very ſmall, as ſuppoſe ſix or ten or more

in

in an Inch: In which case they seem to be even preferable to a Plane Wall, thô the difference between them can be but little.

"The whole direct or unreflected Heat, upon a Semicylindrical Space ADB, is as the "Sectour DAB, the Line DA being directed to "the Sun, and the perpendicular Heat being expressed by a Height equal to the Radius of "the Cylinder. Fig. XIV. *Measure of the Heat upon a Semicylindrical Space.*

"From whence it follows that the Heat, upon the Plane AB, is equal to the Heat, or "Action of the Rays of Light, upon the Cylindrical Space ADB, when the Angle DAB "is of 59 Degrees 4 Minutes, and about 50 "Seconds. And so we leave off considering "of Walls that are not Plane.

An Account of a Table giving, from 40 to 67 Degrees Latitude, the Proportion of the Sun's Heat, in the Solstice, upon a perpendicular and a Sloping South Wall.

I have, for the Reader's satisfaction, calculated, according to the Principles that have been laid down, the following Table, which gives for all Countries, from 40 to 67 Degrees Latitude, the proportion of Heat, in the Summer Solstice, upon a Perpendicular South Wall, and a Sloping Wall passing thrô the Pole of the World. This Space dos comprehend almost all *Europe*. But, in the South parts of it, I should not much care for our Sloping South Walls, unless it were for some Plants of the hottest Countries, or in a place naturally temperate or cold, upon the side of some little Vale duly

The Use of Sloping Walls, in very hot Countries, in such situations as being high, are naturally temperate or cold.

choſen in a high Hill or Mountain. And thus thoſe many Habitations, which, being placed very high, are, in all times of the Year, much colder than the neighbouring Plains, and unfit upon that account, even in hot Countries, for the production of good Fruits, may hereafter injoy that bleſſing. And this ſo much the more, that the Heat of the South Wall may, perhaps without danger, be extremely increaſed there. So, for inſtance, in the middle of *Spain*, which is a Mountainous Kingdom, the Heat may be made, in the Solſtice, ten or fifteen times greater, upon our Wall, than upon a perpendicular South Wall. And this, or rather a part of it, will give a very good help againſt the coldneſs of a Situation, proceeding from its Height.

The Table it ſelf, and its Explication.

" Suppoſe that, in the fourth Figure, the Point " τ is, as before, three times nearer to T than to " V: and that the Cylindrical Surface TMV is " to the Cylindrical Surface TIV as the Arc τμ " to the Arc τι: You will find the Proportion, " between the Cylindrical Surfaces TML, TMV, TIV, " to be, at the Solſtice, as in the following Ta- " ble. The firſt Column gives the Elevation " of the Pole in Degrees from 40 to 67. The " fourth Column gives the Heat TIV, upon a " ſmooth South Wall, ſo much inclined to " the Horizon as to paſs thrô the Pole of the " World; and it makes it always equal to 1000.

The

H P	T M L	T M V	T I V	M N	T M L	T M V	T I V	M. N.
40	65	677	1000	838	100	1043	1540	1291
41	74	690	1000	845	100	930	1348	1139
42	84	702	1000	851	100	835	1189	1012
43	95	714	1000	857	100	755	1057	906
44	106	725	1000	863	100	686	946	816
45	118	736	1000	868	100	626	851	738
46	130	746	1000	873	100	574	770	672
47	143	756	1000	878	100	529	700	614
48	157	765	1000	883	100	489	639	564
49	171	774	1000	887	100	454	586	520
50	185	783	1000	891	100	422	540	481
51	201	791	1000	896	100	394	499	447
52	216	799	1000	900	100	369	462	416
53	233	807	1000	903	100	347	430	388
54	249	814	1000	907	100	327	401	364
55	267	821	1000	911	100	308	375	342
56	284	829	1000	914	100	291	352	321
57	303	835	1000	918	100	276	330	303
58	321	842	1000	921	100	262	311	287
59	340	848	1000	924	100	249	294	272
60	360	855	1000	927	100	238	278	258
61	379	861	1000	930	100	227	264	245
62	399	867	1000	933	100	217	250	234
63	420	873	1000	936	100	208	238	223
64	441	878	1000	939	100	199	227	213
65	462	884	1000	942	100	191	217	204
66	483	890	1000	945	100	184	207	196
67	504	895	1000	947	100	177	198	188
I	II	III	IV	V	VI	VII	VIII	IX

The Explication of the TABLE.

I. Elevation of the Pole in Degrees.

II. Heat upon the perpendicular South Wall, in the Summer Solſtice.

III. That part of the Heat, upon the Sloping Wall, that is not affected by the Air.

IV. Heat upon the Sloping South Wall, in the Solſtice; its Elevation being the ſame as that of the Pole.

V. Middle Numbers, between thoſe of the third and fourth Column.

VI. Heat upon the perpendicular South Wall, in the Summer Solſtice.

VII. That part of the Heat, upon the Sloping Wall, that is not affected by the Air.

VIII. Heat upon the Sloping South Wall, in the Solſtice.

IX. Middle Numbers, between thoſe of the ſeventh and eighth Column.

" And indeed that Heat would be always the " ſame, if it was not for the different Effects of " the Atmoſphere, in ſeveral Climates, and for " the various communication of Heat from the " Ground to the Air, and ſo to the Sloping Wall. " The ſecond Column gives, in the ſame pro- " portion, the Heat TML, upon a ſmooth per- " pendicular South Wall: And the third Co- " lumn gives that part TMV, of the total Heat " TIV, upon the Sloping Wall, that is not af- " fected by the Air. The fifth Column gives " the middle Numbers between thoſe of the third " and fourth. The three following Columns " give the ſame Heats, and with the ſame Pro- " portions; but the Heat, upon the South Wall, " is always expreſt by 100. The ninth Column " gives the middle Numbers, between thoſe of " the ſeventh and eighth. The real direct or " unreflected Heats, upon the Sloping Wall, be- " ing determined, by the Atmoſphere, to ſome " Number between TMV and TIV, they cannot " be very far from the Strength expreſt in the " fifth and ninth Column.

The Uſe of the Table. Example for Paris.

The Uſe of the Table is as follows. Suppoſe I would know what might be at *Paris*, in the Solſtice, the Proportion of Heat, between a perpendicular plane South Wall, and a Sloping plane South Wall, paſſing thrô the Pole of the World. I take the Height of the Pole at *Paris*,

ris, which is 49 Degrees 50 Minutes. "And o-
"veragainſt this Number I find TML, TMV, TIV
"muſt be 183, 781 and 1000. Or elſe that
"they muſt be 100, 427 and 548. I will
"uſe theſe laſt Numbers, as being more conve-
"nient. I conclude therefore that, the Heat, upon the perpendicular South Wall, being ſuppoſed of 100 Parts, the Heat, upon the Sloping Wall, is already, upon a conſideration, which is not at all ſubject to the Effects of the Atmoſphere, of 427 Parts. Beſides an additional Heat of 121 Parts, that would raiſe it to 548 Parts, were it not that from this Number, 121, ſomething is to be ſubſtracted, becauſe of the Effects of the Air. The laſt Column gives the middle Number 487; which we may ſuppoſe is not far from the real Heat upon the Sloping Wall. And this is about 4⅛ times greater than the Heat upon the perpendicular Wall.

Of South Walls that are more inclined, to the Horizon, than the Wall that paſſes thrô the Pole of the World.

"But if we go about to calculate the Heat,
"upon the Sloping South Wall, that paſſes thrô
"the loweſt Point of the Polar Circle, we ſhall
"find the Increaſe of Heat, upon it, to be yet
"much greater.

"And in general a Sloping South Wall, ele-
"vated at *Paris*, upon the Horizon, by ſo much
"as is the Height of the Pole, wanting the whole
"Diſtance between the two Tropicks, being much
"hotter in the Solſtice, than the Sloping South
"Wall,

Perpendicular and Sloping South Walls may be well compared together in the ſame, but not in different Climates.

"Wall, that paſſes thrô the Pole: it follows "that any South Wall whatſoever, whoſe Ele- "vation, upon the Horizon, is there between "2 Degrees 50 Minutes, and 49 Degrees 50 "Minutes, muſt be hotter alſo.

This comparing together of perpendicular and Sloping South Walls proceeds well enough, for the ſame Climate, whether it be often cloudy or often fair: provided the Clouds do not uſe to come more at ſome certain hours of the Day than at others: ſuppoſe more about Noon than in the Morning. But we cannot, from the Table, determine ſafely the Proportion of Heat, between the perpendicular and Sloping South Walls of ſeveral Countries; the Interpoſition of the Air, and eſpecially the difference of Weathers being almoſt an inſuperable Obſtruction againſt it.

Of ſome other Advantages of Sloping Walls:

In the Tract of this Diſcourſe, I have, in ſeveral places, ſhewn ſome of the Advantages we get by uſing Sloping inſtead of perpendicular Walls. I will now run over ſome other Advantages, that are yet untouched, or elſe not fully treated of.

In reference to Dew and Rain; eſpecially as to the Eaſt Wall.

Our Sloping Walls injoy much more the benefit of the Dew and Rain's falling, than other Walls can do. And the Eaſt Sloping Wall will not have, as the perpendicular, that great fault of keeping the Rain from its Trees.

The

The consequence of this will easily be perceived, by those that complain so much of the Drought incident to their East Walls.

In reference to Frost occasioned by the Earths transpiring some moisture:

It is a common fault, in all perpendicular Walls, that the Ground being wet, and transpiring much humidity, this will stick upon the tender Blossoms, and in cold weather cover them with Frost, and destroy them. If our Sloping Walls do not intirely prevent this, they cannot but do it at least in a great measure: the very sloping of the Tree turning it from those Steams, and giving room for them to dissipate themselves in the Air. In like manner our Terrasses will have an advantage in reference to Frost, occasioned by the cold Vapours in the Air driving with the Wind and sticking upon Trees. For one Terrasse dos defend, in a great measure, the following Terrasses against this Accident.

Or by the cold Vapours in the Air driving with the Wind, and sticking upon Trees.

The growing of Fruits extended to more Countries and Places.

By our Theory the Extent of those Places, where several Fruits do grow, will be much inlarged. And not only two Zones of some Miles, or perhaps of some Degrees, round the whole Earth, one of each side the Equator, will be made able to produce, for instance, some good Grapes, whereas they afforded before only some bad or indifferent ones. But in Countries, where Vines do grow plentifully, if you mark upon the Hills, or Mountains, those Limits, where Vines do begin to be but bad or indifferent, even against

gainſt Walls built after the ordinary way; you may often take in yet a great deal more of Ground, with ſeveral Country Houſes and Towns in it, and have there ſome excellent Vines, by the help of Sloping Walls. What is here ſaid of Vines is, in like manner, eaſily underſtood of other Trees.

So then whereas every Climate in *Europe* begins to loſe ſome ſorts of Fruits, for want of Heat and Time to ripen them; we may every where open our Gardens to receive thoſe Fruits, which hitherto we have been unable to have, thô our near Neighbours Southwards did raiſe them, with no extraordinary trouble.

And the time of their Ripeneſs, and uſe for Men, to more Days in the Year.

And not only the Places for the growing of Fruits are inlarged, but ſo are the Times alſo, in which we may injoy them. This advantage ariſing from our Walls giving probably their Fruits a Week, or perhaps a Fortnight, ſooner than we could have them otherwiſe. For ſince at *Paris* the Fruits of good Eſpaliers are ſomething ſooner ripe, than thoſe of Standard Trees; and theſe laſt are ſooner ripe, than thoſe of Dwarf Trees: And, among the Eſpaliers, thoſe of the South and of the Eaſt begin to give ſome ripe Fruits about eight or ten Days ſooner than thoſe of the Weſt, and about, at leaſt, fifteen or twenty Days ſooner than thoſe of the North; is it not eaſie, from thence, to conclude that our

Ordinary Walls compared among themſelves, and with Sloping Walls, as to the forwardneſs of their Fruits.

Slo-

Sloping South Walls and Eaſt Walls will give their Fruits conſiderably ſooner, than ordinary Walls can do?

The Certainty made greater of our latter Fruits coming to Perfection.

The Certainty of our latter Fruits coming to Ripeneſs is alſo much greater; ſince, by our having them early, we need not fear ſo much the beginnings of cold and wet Weather, that might hinder them from coming to Perfection.

Slopes of Earth for ſmaller Plants.

Walls may not only be ſo expoſed, and ſo inclined, as to make ſeveral ſorts of Trees, growing againſt them, to bear early ſome excellent Fruits; but, according to the ſame Idea, the Ground it ſelf may be ſo ſhaped, into Slopes and Terraſſes, as to bring early ſome of the ſmalleſt ſorts of Plants, as Strawberries, Sallets &c. And as for ſuch Plants, as caſt a pretty deal of Shade, thô the ſame Sloping Ground might ſerve very well for them, yet one might alſo uſe, with ſome more advantage, a main Slope cut by Stories into ſeveral ſmall ones faced with Bricks, as you ſee in the fifteenth Figure.

Of the dividing a main Slope into many ſmall ones.

Fig. XV.

Of ſhaping the Level or ordinary Ground, into very large Furrows running Eaſt and Weſt, with a gentle Slope Southwards, and a ſteep one Northwards, or contrarywiſe; in order to increaſe or diminiſh a little the Sun's Heat.

In the like manner we might eaſily ſo ſhape the large Furrows of our Fields, or the Surface of our other Grounds, as to have them expoſed to the Sun, with the ſame Obliquity, as the level Ground of any Country, not above 10 or 15 Degrees more to the South, or North, than we are our ſelves. For inſtance, in the Latitude of *London*, the Ground will have the

Fig. XVIII.

ſame Expoſition to the Sun, as the level Ground, in the Latitude of 45 Degrees, if going from South to North, you make, ſuppoſe for five Yards together, your Ground to riſe by an Angle of 6½ Degrees, in a Slope expoſed exactly to the South; and then you make your Ground to fall as much towards the North, by a Slope as ſteep as it can conveniently be, ſuppoſe of 35 or 40 Degrees: and then you begin again another long and gentle Slope towards the South, for five Yards together, to be followed as before, by a ſhort and ſteeper Slope towards the North; and ſo on. See the eighteenth Figure. Thô we do not, by this, give the ſame Weather, or Heat, to the Climate, nor the ſame Strength, or Weakneſs, to the Sun, as there is in a Country, where its Rays do not paſs thrô ſo much or ſo little Air; yet at firſt ſight it ſeems to be of ſome conſequence for Agriculture, both in cold and in hot Countries; and I could not forbear propoſing it to the conſideration of the Curious. If, in our Example, we do not get that degree of Heat, they have naturally in the Latitude of 45, ſuppoſing both Countries equally cloudy; yet, with the very Numbers I gave, we may poſſibly reach, upon our Ground, the Heat, which they have in 48 Degrees Latitude; and we may yet come nearer the Heat, which the Ground has in the Latitude of 45; if we make our Slope, that looks to the South, a lit-

little ſteeper; raiſing it, for inſtance, 10 or 12 Degrees above the Horizon. There is ſome Ground loſt here, thô not very much. As to the Trouble it is not greater than we ſee Countrey-men take, to make the Water to run off their Fields. And we have this conveniency, that we may give our Slopes only what Breadth we pleaſe; ſuppoſe as much as will reſult from the ſtrength of a Man to throw, with a Shovel, the Earth from him. But the broadeſt Slopes are beſt.

Application of this Practice to Uſe.

Thus we may help and increaſe a little, by the ſhape of our Ground, the Heat of the Sun; or elſe we may abate a little from it. And by conſequence we may fit our Lands the better, to bear any Plants we have a mind to raiſe. This may ſerve to guide ſuch as would plant ſome Vines in their Country, whether it be naturally a little too hot or too cold. For it will either lead them, as daily Experience dos others, to chuſe a Ground fitly expoſed and inclined for their purpoſe: or elſe, if their Ground be not proper, it will let them ſee a poſſibility and a Method, with a little trouble, to make it ſo.

Of the difference of Heat, upon the North and South ſide of Mountains, Hills and Downs.

Every body knows what great difference of Heat and Vegetation there is, in the ſame Climate, between the North and South ſide of great Mountains; and the like is, in ſome meaſure, obſerved, at much ſmaller diſtances, in our Hills. I remember that travelling once in *England*, in

Summer, over ſome Downs, which had but an ordinary Declivity, one could plainly perceive, by turns that the Air became of a ſuddain much warmer, when the Declivity was towards the Sun; and colder, when it lay from it. Yet the Sun being high then did ſhine upon the whole Ground.

The Heat of the Air in any place dos not very eaſily ſpread into the next Air.

In any Shade, and even in our Woods, thô the communication be ſo open with the very next Air, warmed immediately by the Sun, and its Rays are let in at ſeveral places, yet the coolneſs is very ſenſible; the Heat ſpreading from the ambient Air, with leſs eaſe, than one is apt to think. Theſe conſiderations incline me to believe that, by this ſhaping the Ground, there may be ſomething done for the benefit of ſmaller Plants, eſpecially in a cloſe place, or calm weather, when the reflected Heat may not be blown away from the Ground that reflects it. For it ſeems each Surface of Ground makes then, cloſe about it, as it were a peculiar Climate.

Nor the reflected Heat ſpend it ſelf ſo faſt, but that it may be ſtrongly felt.

And this is farther confirmed, by the common Experiment we have, how much hotter it is, in Summer, near a South Wall, or a row of Houſes, that look to the South, when the Sun ſhines full againſt them, than in any other place, where the Light of the Sun comes with the ſame Liberty. For it is plain the reflected Heat, being thus perpetually ſupplied from the Sun, dos not ſo much ſpend it ſelf, into the open Air, but

but that it may be ſtrongly felt, at ſome diſtance, all along the place that reflects it.

I cannot here but mention what I heard a learned Gentleman ſay, who has been in the *Weſt-Indies*. He aſſured that upon their Mountains, according as one goes up higher and higher, and the Heat dos become leſs, one finds, by degrees, very many of our European Plants naturally growing; the Mountains always giving them, in ſome peculiar places, as it were different Climates, fitted to their ſeveral Natures. So then, as the Diminution of Heat makes the Ground naturally to bring forth the Plants of colder Countries: ſo, on the other ſide, the Increaſe of Heat, which in a great meaſure lyes in our power, muſt needs fit our Grounds, and Gardens, for an eaſie and natural Production of the Plants of ſuch Countries, as are hotter, only to a certain degree, than ours.

The uſe of Sloping Grounds, for ſmaller Plants, is pretty well known already; eſpecially beyond Sea. And as for theſe Climates, not to mention what they call in French *des Ados*, I have heard that a Gentleman, who lives at *Dublin*, has in his Garden a pretty eaſie Slope well expoſed; which furniſhes him with Straw berries, long before they be ripe in other Gardens; and with ſuch Strawberries too, as have a colour, ſmell and taſte, to which the others are not tobe compared.

An Account of a Slope where extraordinary Strawberries are ſaid to grow.

Advantage of Sloping Walls, in ſuch Days as the Sun is ſeen for ſome Hours only.

It happens pretty often that the Sun dos ſhine only ſome part of the Day; which makes, at ſuch times, perpendicular Walls, in the Spring and Summer, to be frequently altogether without it. But Sloping Walls, having before them a much greater part of the Sky, are ſo much the more likely to injoy the Sun, if it comes at all to be ſeen. This advantage, as well as that of injoying more fully the Sun, at any Moment it happens to ſhine, is ſo much the more to be valued, when the Climate is apt to be Cloudy, and ſubject to much Rain.

Advantage of inclining Sloping Walls more or leſs, according to the Climate, Situation and Expoſition.

In pretty hot Countries, or in Climates, where their perpendicular South Walls are already as hot, as they deſire to have them, one may often, by inclining another Wall, to a proper quantity, make any Expoſition, from the North Eaſt Southwards to the North Weſt, to be equal in Heat to a perpendicular South Wall. The like may be ſaid of a perpendicular South Eaſt Wall, &c: If it be the beſt perpendicular Wall, in your Climate, you may make ſeveral other Expoſitions not to be inferiour to it, by inclining the Walls, as much as is neceſſary. And further, ſuppoſe Experience has taught, in your Country and Situation, the beſt Eaſt-South-Eaſt Wall, for inſtance, to be, for ſuch a kind of Fruits, that, which is elevated 75 Degrees upon the Horizon; you may

may give such an Elevation to another Wall, in another given Exposition, as will receive an equal Degree of Heat with the former.

Advantage of Terrasses with Sloping Walls, in reference to a sufficient quantity of good Earth, which is easily procured.

Very few Grounds have so much good Earth, as is necessary for Fruit Gardens. The charge of bringing some, from another Place, is very great: And, unless one fetches it from far, there will probably be, too near the Garden and the House, some large unsightly place left in a manner barren and desolate. Neither is it practicable to take away the good Earth, from some Parts of your Garden, to bring it to some other Parts; except as far as your Alleys, and such other Places, will give leave. But, in a Garden for Fruit, made as I shall presently describe, one may find, upon the Spot, so much good Earth, as will much more than double the natural Depth, there was of it before; thô you should plant your Lines of Wall Trees, in the middle of a plat of good Ground, eight or nine Foot wide. And all this may be done, without altering at all the Beauty or Symmetry, of your Disposition.

Fig. XVI.

Description of a Garden for Fruit, according to the present Theory.

The sixteenth Figure is the Ground Plat of a Garden for Trees, made up into Terrasses. It is an exact Square of 470 Foot on each side: that Figure not being so offensive, in our Disposition, as it is in that which is common. If you would have a bigger Garden you may keep the

the ſame Breadth, and add two, or four, or ſix, or eight Terraſſes more &c, and order it ſo that the Door may ſtill remain in the middle. If you deſign to have a ſmaller Garden, you may make the Length of your Terraſſes leſs, by 50, or 100, or 150 Foot. And if you would have it ſmaller yet, you may, inſtead of ten Terraſſes, make only eight, or ſix, &c. The outſide Wall is about 10 Foot high; and broader at bottom, than at top. The Breadth at bottom is 3 or 4 Foot. The Breadth at top might be made of 8 Inches; and it would be better yet, if the Wall ended there into a ſharp Edge. The ſides of the Wall are plane; and ſo they muſt needs be ſomewhat Sloping. Thô this may perhaps ſeem to be of little conſequence, yet I do not doubt but it will be a conſiderable advantage for this Wall, to injoy thus the Sun, near the Solſtice, for about half an hour, or an hour, longer of each ſide, than it could otherwiſe; and at the ſame time to injoy it more fully. To which advantage there muſt alſo be added that of a greater Solidity; which will make the Wall to be more laſting, and ſeldom to want any Reparations. On the inſide of this Wall is a Line of four or five Foot of cultivated Ground; then an Alley round the Garden, and a Chanel, or deep Trench, that may ſerve for a Drain to the Garden. I did ſuppoſe in the

The Uſe of making the outſide Wall thicker at bottom than at top.

A kind of Chanel, or Ditch, to keep the Garden from too much Water.

the Figure that this Canal was faced on each ſide, with a competent perpendicular Brick Wall. But it ſhould always have ſome Water, whoſe Surface ought to be about three or four Foot lower than the Level of the little Walks. One or two of thoſe little Wind Mills, that turn alone towards the Wind, and are ſo common in the Fields in *Holland*, might ſerve to empty this Ditch, leſt it ſhould grow too full; and, if one would, they might alſo ſerve to diſtribute the Water of it to any other place, or to the Alleys, in order to water the Trees. Thoſe Wind Mills might be placed either within or without the Garden; as you think it moſt convenient. The Breadth of the Canal muſt be conſiderable, if you deſign it for ſtate and ornament; but it may be little, if you deſign it chiefly for uſe. Unleſs the neceſſity of having ſome Earth from thence, for the Terraſſes, makes you to chuſe a large Canal. Under the Middle of the Alleys, a croſs the whole Garden, ſhould be as it were a Common-ſhore, to receive all the ſuperfluous Water of the Alleys, and to carry it into the Ditch. And, if one ſuch Common-ſhore was not ſufficient, one might have two placed at equal diſtances, from the Middle of the Alleys; ſo as to leave between them about half the length of the Alleys, or very little more. After the Ditch comes a little Path, and a Line of cultivated

Ground. Then the Slope of the main Terraſſe round the Garden. Then an Alley at the top of it. Then the inner Slope of the main Terraſſe. The reſt are the leſſer Terraſſes, with their reſpective Slopes on each ſide; their Thickneſſes at top; the cultivated Grounds at the foot of them, and the little Walks between. The Door, and Bridge, and main Staires, to get up the main Terraſſe, and leſſer Staires, to go down from it into the Alleys, are eaſily perceived in the Figure; whoſe particular meaſures are as follows hereafter. Thô the Slopings, in all the little Terraſſes, have been made the ſame, and ſuch as are propereſt for latter Fruits, yet it would be more convenient to have them ſomething different. The perpendicular Height of the Terraſſes is 8 Foot. The Slopes that look to the South are elevated 51 Degrees 30 Minutes, above the Horizon. Thoſe that look to the Eaſt 45 Degrees. Thoſe that look to the Weſt 35 Degrees 22 Minutes. And thoſe that look to the North 28 Degrees 53 Minutes. The Height of the South Walls taken along the Slope is 10 Foot 2¼ Inches. That of the Eaſt Walls 11 Foot 3¼ Inches. That of the Weſt Walls 13 Foot 10 Inches. And that of the North Walls 16 Foot 6¼ Inches. The Baſes of the Slopes that look to the South, to the Eaſt, to the Weſt, and to the North have in Breath 6 Foot 4½ Inches, 8 Foot,

Meaſures of the Slopes, which are reſpectively made equal. But being made different they may be better fitted for ſeveral Fruits.

Foot, 11 Foot 3¼ Inches, and 14 Foot 6 Inches. The Door is towards the East.

Expositions of the Walls.	Height of the Walls in the Slope.		Elevations of the Walls above the Horizon.		Bases of the Walls or their *Talus*.		Perpendicular Height of the Walls.	
	Feet.	Inches.	Deg.	Min.	Feet.	Inches.	Feet.	Inches.
South.	10.	2¾	51.	30	6.	4⅓	8.	0
East.	11.	3¾	45.	0	8.	0	8.	0
West.	13.	10	35.	22	11.	3¼	8.	0
North.	16.	6¼	28.	53	14.	6	8.	0

A Table shewing the Heights, Elevations and Bases of the Walls.

Here I bring into one Table the several Heights, Elevations and Bases I said did belong to our Sloping Walls.

I go on to give the Measures of two several Sections cross our Garden.

Measures taken acroſs the Garden, going from South to North.

Meaſures for the Ground Plat taken acroſs the Garden.

Feet.	Inch:	
1.	6	External Slope of the Wall.
0.	0	Breadth of the Wall at Top.
1.	6	Internal Slope of the Wall.
4.	8	Cultivated Ground.
16.	4	Alley.
19.	4	Ditch or Canal.
2.	0	Path.
4.	8	Cultivated Ground.
6.	4⅓	Slope looking towards the South.
13.	0	Alley at the Top of the main Terraſſe.
14.	6	Slope looking towards the North.
4.	8	Cultivated Ground.
4.	9⅓	Path or Alley.
4.	8	Cultivated Ground.
98.	0	

Sums.

6.	4⅓	Slope looking towards the South.
1.	0	Thickneſs of the Terraſſe at Top.
14.	6	Slope looking towards the North.
4.	8	Cultivated Ground.
4.	9⅓	Path or Alley.
4.	8	Cultivated Ground.
36.	0	

Di-

Feet.	Inch:	
36.	0	Divided as before, or with what Alterations one pleaſes.
36.	0	Divided as before, &c.
36.	0	Divided as before, &c.
36.	0	Divided as before, &c.
36.	0	Divided as before, &c.
36.	0	Divided as before, &c.
36.	0	Divided as before, &c.

Feet.	Ineh:	
	6.	4⅓ Slope looking towards the South.
	13.	0 Alley at the Top of the main Terraſſe.
	14.	6 Slope looking towards the North.
	4.	8 Cultivated Ground.
	2.	0 Path.
	19.	5⅓ Ditch or Canal.
	16.	4 Alley.
	4.	8 Cultivated Ground.
	1.	6 Internal Slope of the Wall.
	0.	0 Breadth of the Wall at Top.
	1.	6 External Slope of the Wall.
84.	0	
470.	0	Total Sum.

Mea-

Measures taken acroſs the Garden, along one of the ſmall Alleys, going from Eaſt to Weſt.

Feet.	Inch.	
7.	8	Wall and Cultivated Ground.
42.	4	Alley, Ditch, Path, Cultivated Ground.
8.	0	Slope looking towards the Eaſt.
13.	0	Alley.
11.	3¼	Slope looking towards the Weſt.
305.	5½	Length of the Alley and ſmall Cultivated Ground.
8.	0	Slope looking towards the Eaſt.
13.	0	Alley.
11	3¼	Slope looking towards the Weſt.
42.	4	Cultivated Ground, Path, Ditch, Alley.
7.	8	Cultivated Ground and Wall.
470.	0	Total Sum.

But, with increaſing the Breadth of the Canal every where, by 15 Foot more, the whole Breadth and Length of the Garden would be 500 Foot each.

If

If the Garden be designed for Vines only, the Terrasses need not, I suppose, have more than 4 or 5, or at most 6 Foot, in the Slope that looks to the South; and accordingly they will be smaller, and nearer one another; and by consequence they will be less chargeable; and the same Extent of Ground will yield more Fruit.

Of a Garden for Vines only. It requires but small Terrasses.

Supposing the Ground not to be of the very best sort, but of a middling kind, between that, and the sort of Ground Monsieur *La Quintinye* calls indifferent; the Garden, whose Measures I have just now given, would hold almost 1600 ordinary Fruit Trees; taking in those that may be placed against the outside of the Wall, that goes round the Garden. This will appear upon examining the three following Tables, where I make yet no allowance for the Trees growing bigger, against our Walls, than against the ordinary ones. But the Tables however will very well serve, to guess at the Quantity of Fruits, that will be produced. And this must be with allowing for each Tree according to the common rate of their Fruitfulness.

Of the Number of ordinary Trees the Garden could hold:

From whence is to be estimated the Number of its Fruits.

Height

A Table shewing the Heights and Lengths and Expositions of the Walls.

Height of the Wall taken along the Slope.	Length of the Wall.	Exposition of the Wall, to the Heavens.	The Walls spoken of in this Table.
Feet. Inches.	Feet. Inches.		
10. 0	456. 0	East.	Outside of the Wall that goes round the Garden.
10. 0	468. 0	South.	
10. 0	468. 0	West.	
10. 0	468. 0	North.	
10. 0	458. 8	East.	Inside of the Wall that goes round the Garden.
10. 0	458. 8	South.	
10. 0	446. 8	West.	
10. 0	458. 8	North.	
11. 3¼	347. 6	East.	Outside of the main Terrasse round the Garden.
10. 2¼	360. 4	South.	
13.10	359. 6	West.	
16. 6	360. 4	North.	
11. 3¼	27 Trees	East.	The Nine little Walls, at the Bottom of the Nine Alleys.
20. 2¼ and 13.10	9 Trees	South and West.	The Nine Corners at the right hand, at the going into the Alleys.
16. 6¼ and 13.10	9 Trees	North and West	The Nine Corners at the left hand, at the going into the Alleys.
16. 6¼	297. 0	North.	One of the North Walls of the little Alleys.
16. 6¼	2376. 0	North.	The remaining 8 North Walls.
10. 2¼	297. 0	South.	One of the South Walls of the little Alleys.
10. 2¼	2376. 0	South.	The remaining 8 South Walls.

This

This first Table allows twelve Foot to the Gate and Pillars; and makes the Length of a Sloping Wall middlemost, between its Length at Bottom, and its Length at Top. Only, as to the long Slopes of the little Alleys, observe that they are set down less by 8½ Foot, than what they really are at Bottom: So much being allowed, for the spreading of the Trees in the Corners.

The Result of the first Table is here set down in the second.

Short Table giving the Result of the former.

East.		South.		South and West.	
Length and Height of the Walls.		Length and Height of the Walls.		Length and Height of the Walls.	
914. 8.	10. 0	926. 8.	10. 0		10. 2½
247. 6.	11. 3½	3033. 4.	10. 2½	9 Trees.	and
27 Trees	11. 3½				13. 10

West.		North and West.		North.	
Length and Height of the Walls.		Length and Height of the Walls.		Length and Height of the Walls.	
914. 8.	10. 0		16. 6½	926. 8.	10. 0
359. 6	13. 10	9 Trees.	and	3033. 4.	16. 6½
			13. 10		

Some Suppositions taken from Monsieur La Quintinye:

Monsieur *La Quintinye* divides our Wall Trees into two Classes: and, according to him, if the Ground be between very good and indif-

ferent Soil, the Walls, whose Height is in the Table 10 Foot and 10 Foot 2½ Inches, require the Trees of the first Class to be at eight Foot six Inches distance asunder; and the Trees of the second Class to be at seven Foot three Inches distance asunder. The middle Number between those is about 8 Foot. But the Walls, whose Height is in the Table 11 Foot 3½ Inches, and 13 Foot 10 Inches, and 16 Foot 6½ Inches, require to have their Trees alternately intermixt, with making them by turns a high one and a low one: and their Distances must be about five Foot three Inches, one with another.

By which a Table is made of the Number of ordinary Trees, the Garden would have.

According to these Determinations, the last Table will give the following Numbers of ordinary Trees.

East.		South.		South and West.
Trees.	Distance.	Trees.	Distance.	Trees.
114	8	116	8	
66	5¼	379	8	9
27	5¼			

West.		North and West.	North.	
Trees.	Distance.	Trees.	Trees.	Distance.
114	8		116	8
68	5¼	9	577	5¼

The

The total Sum of Trees is 1595. And for one Tree, that takes up 8 Foot Space, you may ſubſtitute, if you pleaſe, 31 Vines. But if the Ground be very good the Number of Trees will be leſs.

3½ Vines to be ſubſtituted for one Tree.

So then our Garden might hold 1300 ordinary Trees, and 1000 ordinary Vines; or 1400 ordinary Trees, and 680 ordinary Vines. And from thence muſt be eſtimated the Number of its Fruits.

General Sum of ordinary Trees and Vines in the Garden.

But it would be very unwiſe to make ſuch high Terraſſes, to ſerve for Vines only. For that Plant being of ſuch a Nature, as not to do well in theſe Countries, if it be ſuffered, as it is too often done, to ſpend its ſtrength in nouriſhing an overgrown Stock; we may follow their Directions, that adviſe us to keep it ſo low, as to give, for inſtance, to Muſcat only the Height from three Foot to five. A Terraſſe for Vines would then be great enough, unleſs I miſtake in drawing this concluſion, if it was but half as high as thoſe I have deſcribed. Neither would it be neceſſary to allow more than half the Breadth, we did give to our Alleys, or very little beſides. And ſince this great narrowneſs might prove troubleſome, becauſe of the Rain, I would in building the Terraſſes ſpare, within, and at a good Depth under each of them, a little paved Ditch, to carry off the Rain at both Ends, and to keep the Alleys clear of too much Water. The ſame

Of Terraſſes for Vines only.

Vines ought to be kept very low.

La Quintinye.

might also be conveniently done, in building any Terrasses, thô never so big.

Of a large Terrasse parted into two for Vines.

But, if you think it too improper, to have in one Garden a mixture of large and small Terrasses, you might cut one great Terrasse so, as to afford, in the middle of its Height, a Step for another row of Vines; as you see in the *Fig.* XVII. seventeenth Figure. I should however, upon many other Accounts, and also for fear of the Vines of the lower part of the Terrasse intangling with those of the upper part, rather chuse to have a whole Garden for Vines, excepting only the bad Walls in it: And such might be, after some *Fig.* XVI. few changes, the sixteenth Figure; if we suppose the outside to be only of 240, or 300 Foot.

The Garden will not hold so many Trees, as it would, if they were to keep within the ordinary Size.

The Trees in it will grow very large and why: And must be far asunder:

Now, as I did already intimate once before, our Garden will probably not hold so many Trees, as are set down in the last Table. For there being more room with our Walls, than with the ordinary ones, for the spreading and growing of the Roots round about, they will make their Trees undoubtedly to grow bigger, and larger every way. The best Fault, in determining the Distances, between the Trees, is to make them too big at first; for fear of the Confusion, and want of Fruitfulness, that attends those Distances, when they are made too small. However in this we find a new advantage of our Gardens; since a smaller Number

ber of Trees will garniſh the ſame Extent of Walls, and give no fewer Fruits, than a greater Number would have done; and will be withal more vigorous and laſting. But the Difficulty lies in gueſſing at the Diſtances we muſt chuſe. For my part I would, for the firſt Tryal, if the Ground be good, not only make them as great, as the Diſtances, Monſieur *La Quintinye* determines, for the very beſt ſort of Ground; but make them yet, by about one ſixth or one fifth part bigger. Neither would I begin to mix alternately big Trees and little Trees together; unleſs the Wall were, at leaſt, twelve Foot high.

Yet will not yield a leſs Crop of Fruits.

They will be more laſting.

A gueſs at their Diſtances.

See La Quintinye *Vol.* II. *p.* 294. *and Vol.* I. *p.* 208. &c.

We muſt take notice here that the *Paris* Foot, uſed by Monſieur *La Quintinye*, and after him by me, is to that of *London* as 16 to 15. So that to the *London* Foot one muſt add $\frac{1}{15}$ of an Inch, to make it a *Paris* Foot.

Proportion of the London *Foot to that of* Paris.

I have drawn, with a great deal of care, according to the Rules of Perſpective, in a large Print by it ſelf, the Elevation of the South-Weſt Corner of our Garden. Any body may judge, by the effect of this Figure, particularly with hiding the lower part, whether Sloping Walls and Sloping Trees will be much offenſive to the Eye. For my part I think it may be a queſtion whether an ordinary Fruit-Garden, with perpendicular Walls, can ever be made to look ſo pleaſant,

A Draught of the Garden in Perſpective. Pag. 1.

ſant, and ſo full of a regular and ſtately variety, as I find the Figure to be. That ſtatelineſs is altogether owing to thoſe great and maſſy Terraſſes, which, in our Draught, overrule, as it were, and maſter the whole; and have an effect like to that of very large Columns, in our Buildings. They have beſides, from ſo many Trees ſet againſt them, in a regular order, that Airineſs and Gayity, which ariſe in our Architecture, from abundance of proper Ornaments. The Canal is made broader than according to the meaſures of the Ground Plat. It will not only be nobler, if it be very broad; but, if you have no natural riſing, in the midſt of your Ground, it may yield alſo the Earth neceſſary for the Terraſſes, without ſinking the level of the Garden. The Figure will help to conceive how ſome Roofs might be uſed, inſtead of Terraſſes.

Diviſion of a large Garden, by ſome Canals, into four or ſixteen little Gardens, or any other Number.

If the Garden be very large, and you are at a loſs where to have all the Earth, that would be required; even thô you ſhould pretty much increaſe the breadth of your Canal; keep the outermoſt ſquare Terraſſe untouched; and in the middle of your Ground Plat, draw, from ſide to ſide, a large Canal, like a Croſs, ending at the four ends perpendicularly againſt the main Terraſſe. This new-Canal will give the Earth you want: And each of the four Diviſions of the

This will yield the Earth neceſſary for the Terraſſes.

the Garden muſt be finiſhed by it ſelf, according to the Idea I have followed, in the ſixteenth Figure. Only the new Terraſſes, that go round the inner half of the four Diviſions of the Garden, and make up the Banks of the new Canal, ſhould not be ſo large, as the main Terraſſe.

After the ſame way, if the Extent of the Ground was extraordinary great, and there was yet ſome Earth wanting one might again, by four new Canals like a Croſs, ſubdivide each of the four laſt Diviſions: which would give ſixteen ſmall Gardens in all. If theſe Canals be deſigned for ſeveral Ponds, where you may keep different ſorts of Fiſhes, they need not have any communication one with another. But if you would have the liberty of going every where, with Boats, among the Gardens, it will be ſufficient, if all the Canals be opened, and continued into one another, along that Branch of the main Croſs, which the Bridge dos come up to: excepting only that part of the main Terraſſe, the Bridge ends againſt. Thus you might go, at your pleaſure, either with a Boat, or walking, to any one particular Garden. As the outer Terraſſes are made leſs and leſs, according as their Length decreaſes, ſo ſhould alſo the Canals be made leſs and leſs broad. Now, by ſuch Canals, your Garden might be divided, not only into four or ſixteen ſmaller Gardens, but into any other Number. Thô

And either give different Ponds for ſeveral ſorts of Fiſhes: Or elſe open the Way, by Boats, among the Gardens:

And leave alſo a Foot Way into them all.

Any ordinary Gentleman may have a few Terrasses, or Slopes, well exposed.

Thô such large and magnificent Gardens can only be the Work of Princes, and other Great Men, or of powerful Societies; yet there is no ordinary Gentleman, that is able to have a Garden, but may, according to his ability, and the Directions I have given in other places of this Discourse, have one or more Terrasses, or Slopes, well exposed, of what length he can afford: So that he may have, against them, a competent number of Vines, and other Trees. And whereas they say now, for instance, I have got fifty Yards of very good Wall; they may say hereafter, to a greater commendation of their Gardens, I have raised 30 or 40 Yards of a Sloping South Wall.

A Tryal of Sloping Walls not to be depended upon, unless made by a very good Artist.

It may happen that, upon some Tryals made by an unskilful Artist, our Walls may seem not to be of any use, for the Production of good Fruits. But ordinary Agriculture dos not now thrive equally, in everybody's hands. And whilst a diligent and understanding Country Man is largely repaid for his Care and Industry, the unskilful often sees himself deceived in his hopes. There will ever be a just distinction, between those that act by the certain Principles of an Art grounded upon Nature, and such as act in a great measure by chance. The same Instruments, according to the several Applications that are made of them, being managed by two several Hands,

Hands, produce often both what is deſervedly admired of one ſide, and what is as deſervedly deſpiſed on the other. In a word, I do not hope, by this Theory, to make all Gardeners equal among themſelves. But I give them, in all Countries, an eaſie, and natural, and very great Increaſe of the Sun's Heat; which may often aſſure them of an extraordinary Succeſs; thô without excluding the neceſſary Care and Skill, which after all is the moſt ſignificant Part.

A good Culture more ſignificant than a good Expoſition.

If what I have been propoſing might, at any time, have been acceptable and uſeful to Mankind, it muſt certainly be ſo now. Every body has been ſenſible, for theſe twelve or fifteen Years, of a very great, and, as ſome think, unaccountable Change in our Seaſons. Our Summers are much colder than they were; and 'tis but ſeldom they bring us any Thunder. Their Influence is felt in many of the Productions of the Earth; particularly in all ſorts of Fruits, that come late in the Year: for ſuch have no Heat to bring them to perfection. And the unſettledneſs of our Springs commonly deſtroys the very firſt hopes we have, at the bloſſoming of our Trees. The cauſe of this Change, in our Seaſons, is often the Subject of common Diſcourſe: And it is no wonder to ſee how wide and empty the gueſſes of moſt people are, upon that matter. This is certain, and was made out

Sloping Walls very neceſſary, while our Summers continue to be ſo cold.

The cause of that change in our Seasons referred to a Phenomenon like Smoak, that incompasses the Body of the Sun, and is seen to spread an exceeding great way from it.

heretofore past dispute, that from the Year 1683 downwards, and I say now even to the present time, the Sun has been in the very Middle, or Center, of a thin Mist of a prodigious Extent; 'which, incompassing the whole Body of the 'Sun, spreads near the Plane of the Ecliptick, so as 'to reach almost the great Orb of the Earth; re-'sembling much, in its Figure, an ordinary O-'cular Glass, or Lens, equally convex on both 'sides. Its Thickness or Opacity (not where it 'is greatest, but where we may begin to see it, 'when the Night is already become dark) is like 'that of the Tail of a Comet, or the Milky 'Way. But it is yet considerably greater, just 'in the Line that passes from the Earth thrô 'the Body of the Sun. Whoever has seen this Vail, that is spread between the Sun and us, will easily grant that it must needs take off some part of its Heat. There has not yet been found, at least as far as I know, any other old Footstep of this strange Phenomenon, but that in 1660, Mr. *J. Childrey*, in his *Britannia Baconica*, has printed that he had observed it several Years together, and he desired Astronomers to mind it. Thus much seems very possible, that it might be many Years unobserved in the Sky, and perhaps have continued for some Ages, without being minded. But the very change in our Seasons seems now to be a Proof, that it has either not been

been at all, in former times, unleſs we ſhould find in Hiſtory ſuch another Series of cold Summers, or at leaſt that it is has not been ſo thick, or has not laſted ſo long, as at preſent. The true Syſtem of the World having at length been diſcovered, by the immortal Mr. *Newton*, we may perhaps gueſs more exactly, than heretofore, at the natural Cauſes of this Appearance. 'It ſeems 'then, at leaſt, the outſide of it, to ariſe from 'ſome Fumes, or Exhalations, which the Sun 'throws up, with an equal Strength, and the 'greateſt it can, all about its Body, perpendicu-'larly to the ſeveral points of its Surface. And 'the Sun revolving at the ſame time, about its 'Axis, in ſome 25 Days, occaſions the ſpread-'ing of that Smoak, near the Plane of the Sun's 'Equator, much farther than it dos towards the 'Poles. The Parts of Smoak, whoſe Swiftneſs 'is not ſo great, do not riſe ſo high; and per-'form all their Motions, within the Body of the 'Phenomenon; not being able ever to come 'near its Extremity. And, ſuppoſing ſeveral 'Degrees of Swiftneſs in thoſe Particles, the Phe-'nomenon ought to grow much denſer, as one 'approaches the Sun: which our Obſervations 'alſo do confirm.

The Origine of that Smoak.

'From the Suppoſition that the Particles of 'Smoak, that fly out at the Sun's Equator, per-'pendicularly to its Surface, are able to riſe ſo

How to determine the Figure of the Space it lies in.

'far, as to reach, as by Obſervation they are 'ſeen to do, the Circumference of a Circle, that 'ſeems, at its Extremity, to be removed from 'the Sun by about 70 Degrees, I have calcula-'ted how high would riſe the Particles that ſhould, 'with the ſame perpendicular Velocity, fly out 'of the Poles of the Sun. And the Calculation 'gave me that Height, as agreed very well with 'the Breadth, the Phenomenon ſeems to have 'in all its Parts. It would have been eaſie, up-'on the ſame Grounds, to make the like Cal-'culations, for ſo many points in the Section 'thrô the Axis, as would have made it ſufficiently 'known; and by conſequence have ſerved to 'eſtabliſh, or overthrow my Conjectures. But 'as yet I have neglected to do it. And this is 'no proper place to handle this Subject more 'exactly.

'I ſhall only ſay that I look upon each Parti-'cle of Smoak, that riſes from the Sun, as ha-'ving its Motion as free, as if it was a Planet: 'The ſame being obſerved alſo in the Smoak, 'that compoſes the Tayl of Comets. So then 'each of our Particles revolves in an Ellipſis, 'till being near the end of its Revolution it falls 'into the Sun again. The whole Body of the 'Phenomenon is thus perpetually ſupplyed a-'freſh, ſomewhat in the nature of thoſe *Jets d'Eau*, 'or Water Spouts, they call in French, *des Gerbes*.

'The

'The extraordinary ſmall number of Spots, that 'appear for theſe many Years ſo ſeldom in the 'Sun, whereas in the firſt half of this Age they 'were ſo very numerous and ſo frequent, leads 'us to ſuſpect that the matter of thoſe Spots has, 'for ſeveral Years, been kept evaporated and diſ-'perſed, in all the Space I have juſt now deſcri-'bed.

It may grow thicker, and yet not be perceived to have changed, except perhaps by its Effects.

'For ought we know yet this Phenomenon 'may, at ſometimes, by the ſupervention of a 'thicker and heavier Smoak, grow denſer about 'the Sun, than at other times; thô the outſide 'of it ſpreads but to the ſame place, and ſeems 'not to increaſe in thickneſs. So that our Heat, 'in our Summers, may very much alter, with-'out our being able to perceive any Change, in 'the outermoſt Part of the Phenomenon; which 'is the only Part viſible to us; unleſs the Sun 'ſhould be totally Eclipſed; and give us, in the 'middle of the Day, an Image of a dark 'Night.

Some

Some Directions relating to Fruit Walls.

Directions about Garden Walls ought to be taken from Monsieur La Quintinye, *and the present Discourse.*

LET the Rules and Directions given by Monsieur *La Quintinye* be supposed here, as the main Foundation of our Hopes, in raising Fruit Trees. To which Rules must be joyned those, that may be gathered, from the present Discourse. And to the whole the following Maxims may be yet added; some of them being only an Abridgment of what I have already treated of more at large, and some others being yet untouched.

Let your Walls be straight.

Let all your Walls be plain, and straight on both sides.

How they must be if they stand by themselves, without any Earth on either side.

If they are to stand by themselves, without any Earth or Terrasse on either side, let them be thicker at bottom than at top, where they must end as it were into an Edge.

Fig. XIX.

That Edge, which is at the Top of the Wall, should stand over the Middle of its Thickness at Bottom, if you would have the Wall to be most solid and lasting. But, if you intend to favour the Trees of one side, more than those of the other side, where perhaps it is not in your power to have any Trees, the Top of the Wall may be removed, going from that side, you intend to favour, towards the other; provided it dos yet bear directly over some part of the Bottom.

And

And this will make that ſide the ſteeper, which probably you deſign for the outſide of your Garden.

The broader your Wall is at Bottom the better it is for Vegetation; but the charge is alſo greater. 2½ or 3 Foot may be a competent Thickneſs. The Height will be well from 8 to 10 or 11 Foot. A higher Wall would be more chargeable, and, unleſs the Breadth at bottom be alſo increaſed, it would be leſs hot, and would not laſt ſo long.

Walls of darkeſt Colours are beſt.

How if they reſt againſt a Terraſſe or Slope of Earth. Fig. XX.

If your Wall is to reſt againſt a Terraſſe, or Earth, having a Slope faced with Bricks on the other ſide, it will be well that the Plane, which parts the Earth and the Wall, be perpendicular to the Horizon; which will make the other ſide of the Wall ſo much the more Sloping. And let the ſeveral Beds of Bricks, which make up your Wall, be, not Horizontal, but a little leaning towards the Terraſſe. So the Wall will be able to witſtand better the Preſſion of the Earth.

Let the Earth of the Terraſſes be throughly ſetled.

Let the Earth of all your Terraſſes, or other Sloping Grounds, which you intend to face, be throughly ſetled, or well beaten, before you face them. Leſt that Earth, by coming to ſink, ſhould ſpoil the Regularity of your Wall.

The

The perpendicular height of Sloping Walls.

The perpendicular Height of such a Wall as this needs not be more than 8 Foot.

If you would have a Terrasse, with solid Walls on both sides, they must be built after the same way.

Their Inclination.

Let the Inclinations of all your Terrasses be made, according to the Directions, I have given at large, in the present Discourse.

If your Terrasse be very Sloping on both sides, let it have some little Thickness at top; that the Earth coming more and more to settle, the two Walls, that face it, may not come to touch one another.

Of a broad Terrasse and how it may be made;

Fig. XXI.

Fig. XXII.

Terrasses that are flat at top, with a Walk there, are very Noble and neat. But if this Walk be broad, you may consider whether you had rather build two Walls breast high, on both sides of the Terrasse, so that the facing of it be not altered by them. This will save the charge of bringing so much Earth, and is capable of the Ornaments of Architecture, or else may be performed after a very plain way, and with little charge. It is most proper for such Terrasses, as have both their sides almost equally leaning. Such are those that run from North to South, or from North West to South East.

When its sides are almost equally leaning;

Fig. XXIII.

Fig. XXIV.

You might also have a Wall breast high, only of one side of the Terrasse; which would spare some charge, and be pleasanter in walking.

This

This is very proper, when your Terraſſe runs from Eaſt to Weſt: for thus your South Wall, having at the Top of it the Wall breaſt high, your North Wall will have a more proportionable Height for Trees. See the Figures quoted in the Margin.

And when the Terraſſe runs from Eaſt to Weſt.

The Ground of your Alleys may be made Sloping by ſome 5 or 10 Degrees &c, towards the South: which will expoſe it better to the Sun; and cauſe the Water to run more towards the North Wall, or worſt ſide; and make the Ground near the South Wall to be the dryer. This will be particularly proper for Vines, which thrive beſt in a pretty dry Ground; and for a Country ſubject to much Rain.

The Ground of Alleys for Fruit may be made Sloping towards the South.

Your North Wall might be left bare, without any Trees; which would make the reflected Heat to be much the ſtronger, upon the South Wall. And then, at the Foot of the North Wall, might be ſown ſome Plants that require, in your Climate, in the Spring and Summer, much Sun Shine, and a Ground not very dry. Such might be ſome Strawberries, or any other ſmaller Plants, that are common in Gardens. So then one ſide of your Alleys may be for Fruit, and the other ſide for all ſorts of Herbs. But, if you think fit, the Earth of the North ſide may wholly reſt, and be kept in ſtore, to renew the Earth of the South ſide, as there ſhall be occaſion.

The North Wall may be left bare, and Herbs ſown at the foot of it:

Or elſe the Earth be kept reſting, in order to renew that of the South Wall.

Slopes preferred to Walls. You may order, after the manner I have ſaid, whatever Walls, or Terraſſes, you build; prefering always a Terraſſe, with a Slope on each ſide, faced with Bricks, to an Earth, or Slope, walled on one ſide, and only faced on the other: as this muſt be preferred to a ſimple Wall, without any Earth.

If you can have but one Slope, give it the beſt Expoſition. I need not ſay that, if in your Garden you will have but one Slope, it ſhould be againſt the beſt Wall, and reach the very Top.

Of a Slope round the Garden. A Garden may very properly be ſurrounded by a Slope of Earth, walled on one ſide, and faced on the other; the Wall being at the outſide of the Garden. But, if you pleaſe, you may not make the Slope, that would look to the North.

Of a Terraſſe round the Garden. *Of more Terraſſes in the Garden.* If you will be at a greater Expence, you may have a flat Terraſſe round your Garden. Or elſe, before your Slope, that looks to the South, build a ſharp Terraſſe, having the whole length of your Garden. The ſame you might do along your Slope, that looks to the North. And ſo you might have as many Terraſſes, as you pleaſe. But it is beſt not to part them, by a Garden between, but to keep them all together; becauſe they will be thus better ſheltered againſt Winds.

Of Flat and Sharp Terraſſes. A flat Terraſſe is that, which has a convenient Walk at the Top of it; whether it be walled or only faced on both ſides. A ſharp Terraſſe is, for the moſt part, only faced on both ſides,

an

and ends at Top, as it were into an Edge; there not being Room enough for a Walk. It may also be walled on one side, and only faced on the other. The same may be said of a Flat Terrasse.

A Sharp Terrasse is preferable to a Flat Terrasse for Cheapness. A Flat Terrasse is preferable to a Sharp Terrasse for State, and for the convenience of the Walk it affords.

Description of a Walk very well secured from Winds.

If your Climate be subject to very dangerous Winds; from which your Walls must be secured at any rate; the best will be to make, in a convenient place, two Terrasses, running exactly from East to West, like those of the second and third Figure. I have no new Directions to give, about the Insides of those Terrasses. They must be faced with Bricks; and, the Side exposed to the South being used for Fruit, the North Side may either wholly rest, or be employed as you think fit. But, as to the Outsides, these not being designed for any use, you may make them as steep as you please. Then you may fill the whole Spaces, comprehended by the indefinite Lines, or rather Planes, AM, AO; EN, EP, continued as far as you think fit, with Trees, and very tall and thick Hedges &c; or with Buildings, and whatever else is able to stop the Wind. Both the Ends of the Alley must be stopped, by a cross Terrasse each; and, at their outside, the

Fig. II. III.

ſame care muſt be taken for a Shelter, of very tall Hedges and Trees, againſt Winds.

Thus the Walk, between your Terraſſes, will be ſheltered, as much as poſſible, and the Heat in it will be very cloſe, and the Sun Shine, that is loſt, will be inconſiderable.

I do not mean only that ſuch Buildings and Plantations, as I ſpoke of, may be made about your Walk, to ſecure it from Winds: but that you may alſo take your advantage of Buildings already made, and of Trees already planted, even of thoſe of a Foreſt, to make your Alley between them, and to ſecure it, by the Shelter they will afford.

Of the Diſpoſition the Roots ought to have, in a Tree that is to be planted againſt a Sloping Wall.

The Roots of the Trees, we are to plant againſt our Sloping Walls, ſhould not be diſpoſed after the ſame way, as if the Walls were perpendicular. If there be but one Root, it is beſt placed, when it makes an Angle, with the Body of the Tree, equal to the Angle of the Sloping Wall, with the Cultivated Ground. And then ſuch a Root, being turned from the Wall, will be Horizontal. But, thô the Root made a ſmaller Angle with the Tree, yet there will be commonly ſome poſition, where it will naturally place it ſelf, in your Cultivated Ground, in an Horizontal Situation. But this muſt be done with judgment; ſo that the Roots, of different Trees, may not too much intermix.

If

If there be but two Roots in your Tree, when they are oppoſite, and both Horizontal, place them parallel to your Sloping Wall. If they be not directly oppoſite, they will be beſt, when they both bend a little downwards, from the Body of the Tree. And you will eaſily find what Situation is beſt, for the Tree, with keeping its Body parallel to the Situation it is to have, and, at the ſame time, turning the Tree about its own Axis. After the ſame way, whatever be the number of your Roots, and their Situation, you will know how to place the Tree, if you indeavour to find how all the Roots, without running too deep, from the places, which are heated by the Sun, can beſt remain under Ground: eſpecially under the Cultivated Ground, which receives more the benefit of the Dew and Rain and Sun Shine, than that which is under the Wall. And, when the Roots are long and pliant, you may place them, at your pleaſure, in a Situation parallel to the Surface of the Ground, or to the Plane of the Wall; according as they are near the one or the other of thoſe.

Deſcription of a Ladder to be uſed about Sloping Walls.

The Fruits that grow pretty high, from your Cultivated Ground, will require that you ſhould have, in order to gather them, a Ladder ſomewhat particular, with two Arms at the upper End, by which it may be kept from the Wall, and from the Trees. And ſuch a Ladder, being once

once fixed, will be near parallel to the Wall; and will ſerve to gather at once all the ripe Fruits in that place; or to do all the neceſſary Work about the Trees, be the Wall never ſo high; till you remove the Ladder, to another part of the Wall.

Of Harbours and Summer Houſes, in our large Gardens.

Some Harbours, Cabinets, or Summer Houſes, in our large Garden, might be very well placed at the four Corners. They ſhould have the full Breadth of the Alleys, or rather more; ſo that they may face the middle of them directly. And the Walks may be continued into one another, by cutting a round Space, from the Corner of the Canal. I have drawn, in one of the Corners of the ſixteenth Figure, ſome pointed Lines, which ſhew how I mean thoſe Summer Houſes ſhould be made; and what changes they will give, both in the Alleys and Canal, and in the Corners of our main Terraſſe.

Fig. XVI.

Smaller Harbours, or Grottos, may be made under the Terraſſes; and may ſerve for ſhelter againſt Storms, and for Store-Houſes for our Fruits: not to keep them there for a good while; but to lay them up, till they be carried to a more convenient Place. They may be of about ten Foot Square; and have their Floor lower than the Ground: and cauſe no other change, in the outer Part of the Terraſſes, but that a Way muſt be cut to them, along that Corner of the Walk,

Walk, which is exposed to the North West. They must have a good deal of Air from the Door &c. And, according as you would have them dry, you may have, under your Trees, in the South Wall, a small Window, of a convenient bigness, so much raising from the Wall, as to exclude the Rain. And, if you fear lest your Harbour, or Store-House, might prove too damp, you may make it narrower, and spread it under a greater length of the Terrasse. This will give you the liberty of making the Floor higher, and level with your Alley, or raised above it, by two or three Inches, or more.

Of Ornaments of Architecture, in a Wall altogether smooth.

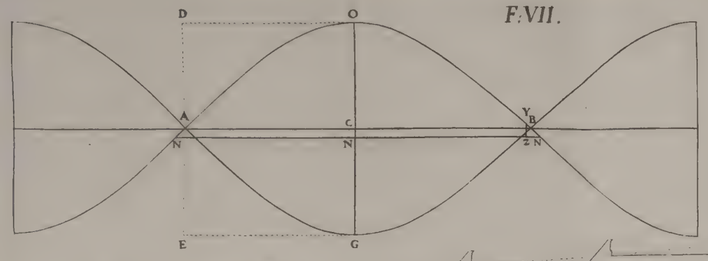
One is not apt to think that a Brick Wall, altogether smooth, and without any jetting out, and Windows, should be capable of some pretty Ornaments of Architecture. Yet I find it may be very much imbellisht, barely by the different Disposition of the Bricks: And I have given an Instance of it, in the Frontispice. There I made use only of Bricks, whose Measures are as follows.

Ordinary Brick;	Length	4 Parts;	Breadth	2.
Double Brick;		4.		4.
Half Brick square;		2.		2.
Half Brick long;		4.		1.
Quarter Brick;		2.		1.

But

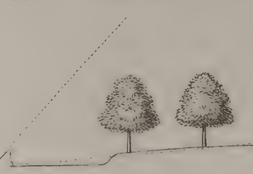
But one might also imploy Bricks of different Colours and Sizes. What is done in the Frontiſpiece, for imitating an Architrave, Freeſe and Corniſh, might also be done for Pilaſters, and for large Partitions between them, like the Square Frames of our Wainſcot, or like our Windows. I ſay this, after having tried it, and perceived that even the *Schizzos* I made looked noble and pretty; and imitated our good Architecture, beyond what I could have expected, without having any thing either Gottick or Fanciful. The Example you have, in the Frontiſpice, is very much inferiour to what might have been done, if there had been more Room. And not only the Modillons, of the fineſt orders, might be eaſily imitated; but ſo might also the Triglyphes, and Metopes, of the Dorick.

F. VII.

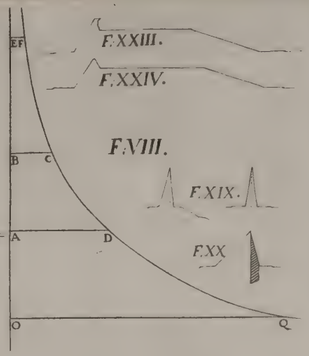


F. XXI.

F. XXII.



F. XXIII.



F. XXIV.

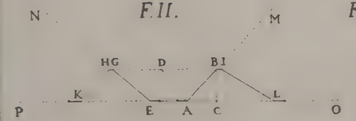
F. VIII.

F. XIX.

F. XX

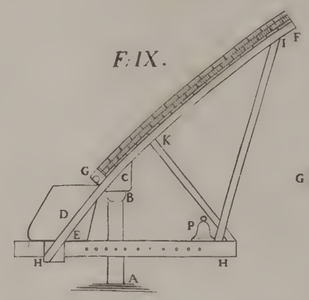
F. I.

F. II.

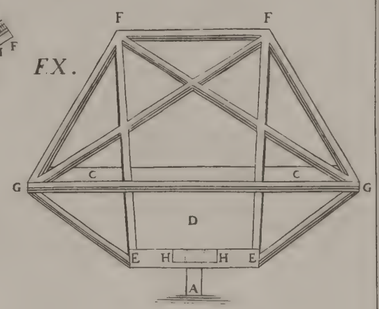


F. III.

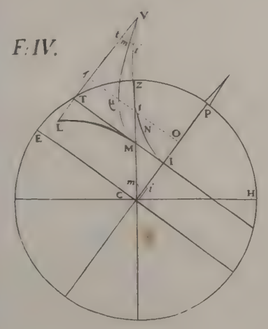
F. IX.



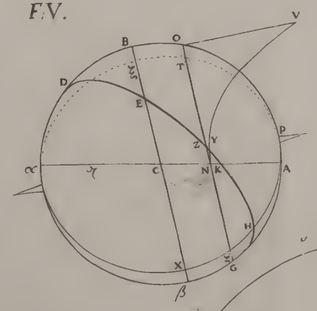
F. X.



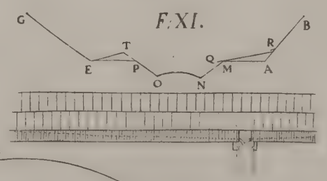
F. IV.



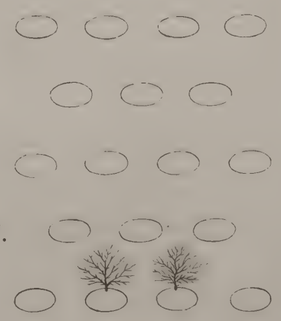
F. V.



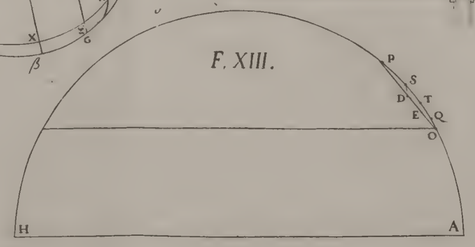
F. XI.



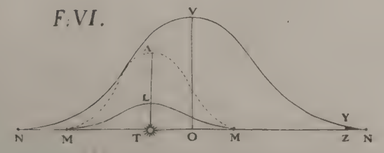
F. XII.

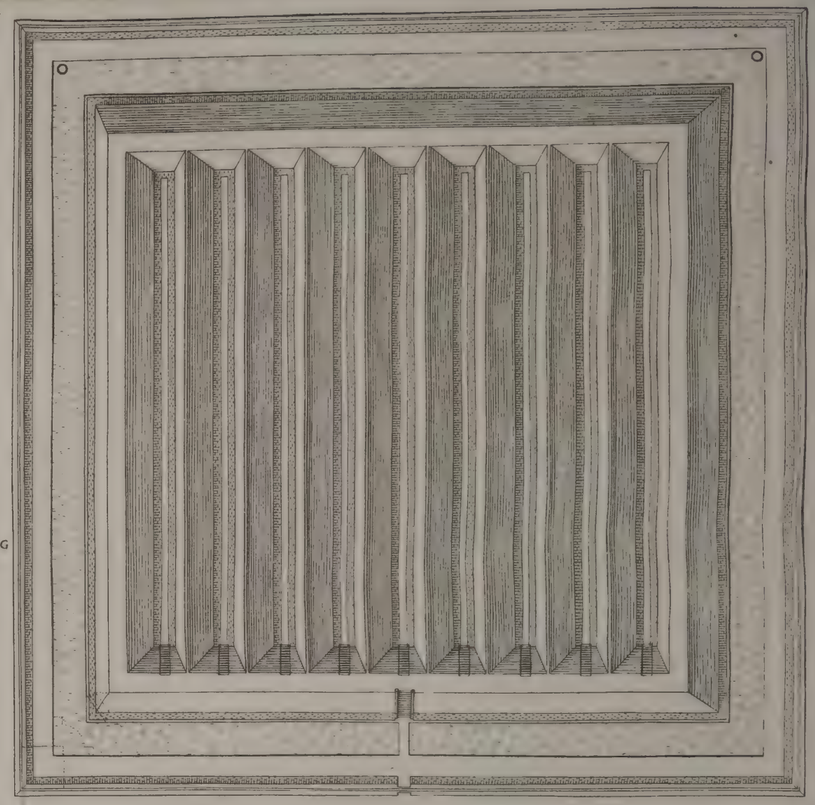


F. XIII.

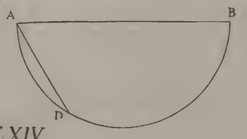


F. VI.



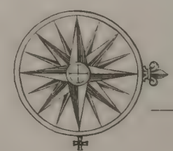


F. XIV.



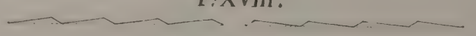
F. XV.

F. XVI.



F. XVII.

F. XVIII.



S. G. Sculp:

NICOLAI FATII DUILLIERII,

R. S. S.

LINEÆ BREVISSIMI DESCENSUS INVESTIGATIO GEOMETRICA DUPLEX.

CUI ADDITA EST

INVESTIGATIO GEOMETRICA SOLIDI ROTUNDI,

IN QUOD

MINIMA FIAT

RESISTENTIA.

LONDINI:

Typis R. *Everingham*: Proſtant apud *Johannem Taylor*, ad Inſigne *Navis*, in *Cæmeterio Divi Pauli.* M DC XC IX.

Imprimatur

Liber cui Titulus, Nicolai Fatii Duillierii Lineæ Breviſſimi Deſcenſus Inveſtigatio Geometrica duplex, &c.

J. Hoskyns, V. P. R. S.

NICOLAI FATII DUILLIERII,

R. S. S.

LINEÆ BREVISSIMI DESCENSUS INVESTIGATIO GEOMETRICA DUPLEX.

* "CURVAM Celerrimi Deſcenſus, a ſe prius "inventam, Geometris intra ſex Menſes "perquirendam, publico Programmate, pro- "poſuit Cl. Dn. Jo. Bernoullius: ſcriptiſ- "que Litteris Cl. Leibnitium rogavit, ut aliquid tem- "poris, huic Problemati ſolvendo, impenderet.

* *Vide Acta Lipſienſia Menſis Maij 1697.*

"Leibnitius ipſe, velut Miſſione dudum impetrata, "potuiſſet quidem (verba ſunt Leibnitii) hoc labore "ſuperſedere; tamen, Problematis pulchritudine ca- "ptus, mox ipſum tentando, voti fœliciter compos fa- "ctus eſt.

"Sex præſtitutis Menſibus elapſis, nullo alio inven- "tam ſibi Solutionem ſignificante, Leibnitio Bernoul- "lioque *placuit, ut, Programmate novo, Terminus ad ſex ali- "os Menſes prorogaretur; tametſi præviderent EOS IPSOS, "quos Solutionem tandem aſſecutos cognovtrunt, ad eam eſſe "perventuros.* Et ſane, inquit Leibnitius, notatu non "indignum eſt, EOS SOLOS ſolviſſe hoc Problema, "quos SOLVERE POSSE conjeceram. Erant hi, "præter præfatum Bernoullium, Cl. ipſius Frater; "Marchio Hoſpitalius; Hugenius, ſi vixiſſet; Hud- "denius, niſi hæc Studia dudum intermiſiſſet; Newto- "nus, ſi operam hanc in ſe recepiſſet.

Newtonus quidem, Programmate ad ipsum missso, provocatus, Solutionem suam dedit ; ægre ferens, tale quid ab ipso requiri, post datam Solutionem difficilioris Problematis, de inveniendo Solido rotundo, longitudinis ac latitudinis datæ, cujus Resistentia, dum secundum Axis sui plagam progrederetur, foret omnium minima. Quod eo magis potuit Vir Summus, quo nemo aut diutius, aut pari jure, plenissimam, ut Leibnitii verbis utar, missionem esset emeritus.

" Cl. Jac. Bernoullius, quanquam Fratris provoca-
" tione se non teneri existimaret, tamen, superacce-
" dente humanissima Leibnitii invitatione, ejus Litteris
" ac sollicitatione motus, Problema fœliciter aggressus
" est, quod alias intactum reliquisset.

" Illustrissimus Marchio Hospitalius, cum difficile
" admodum prima fronte ipsi videretur Problema, nec
" firma satis uteretur valetudine, ab illo abstinere pri-
" mum decreverat. Desidem, ac operis asperitate de-
" territum, erexit Programma Bernoullianum, quo Ge-
" ometras, ad hujus Problematis Solutionem, iterum
" invitabat. Neque spem fefellit, imo superavit, e-
" ventus.

Nos vero, si qua Invitatione, si digni visi fuissemus Litteris, quamvis inter tot egregios Candidatos innominati, nec adhuc in eorum numerum relati, quos SOLOS tanto Problemati pares Cl. Leibnitius pronunciet, utique nostras dudum exhibuissemus Solutiones. Nec enim causa erat, cur antiquum morem nostrum, Problemata omnia in Vulgus jacta prætereundi, mutaremus. Sed, cum videamus Silentium nostrum in nos ipsos verti, quod hac in re præstitimus exponemus, quantum fieri poterit brevissime.

Liceat autem idem omnino scriptum edere, quod * nuper Chartæ commisimus, ante visa a nobis Anni 1697 Acta, quæ per aliquot Menses frustra, inter Londinenses Bibliopolas, quæsivimus. Illa enim quæ, in Proœmio, mutari oporteret, ubi duos tantum agnoscimus

* *Mense Julio* 1698.

noſcimus Geometras, qui Problematis Solutionem invenerint, facile ex jam præmiſſis ſupplebit Lector. Neque vero immerito ſuſpicabar, iſta proponendorum Problematum luxurie, Principatum quendam, inter Mathematicos, affectari; quicquid in contrarium regeratur: ſiquidem quicunque Solutiones nullas hujus Problematis dederunt, impares ipſis inveniendis ultro, ſolennibus Actis, promulgantur.

Lineæ Breviſſimi Deſcenſus Inveſtigatio Geometrica Prior.

ACcepimus Præclariſſimum Geometram, a quo propoſitum eſt Problema, de invenienda Linea Breviſſimi Deſcenſus, a dato Puncto ad Punctum aliud datum, Amico ſcripſiſſe, Solutionem ejus Problematis, quam in Tranſactionibus Philoſophicis viderunt Eruditi, Newtonum Auctorem procul dubio agnoſcere. Ejuſmodi Problemata, quamvis a me non ſemel ſoluta, verbi gratia circa Catenariam, Velariam, harumque Linearum identitatem, Curvam Deſcenſus Æquabilis &c, magnopere ſemper averſatus ſum; neque Solutiones meas publicis ſcriptis unquam dignatus ſum exponere. Quid enim aliud, proponendis ejuſmodi Problematis, affectari videretur, niſi hic mos inter cordatos etiam invaluiſſet, præter exiſtimationis ſupremam dignitatem? Quam modeſtioribus facile præripiant, quicunque, ſibi ipſis inventa difficiliora Theoremata, ſub Problematum forma, Mathematicis proponant. Quaſi vero manus darent, quicunque, in arenam e veſtigio deſcendere nolentes, intra præſtitutum tempus, Problema non ſolviſſent. Problema, inquam, cui ſolvendo Auctor opportunum otium nactus fuerit; cui tractando multos Annos forſan inſudaverit; quod elegerit ipſe; quod amaverit, ac ardentiori ſtudio proſecutus fuerit; cui enodando viam facilem, cognatis ſtudiis

diis, sibi paraverit; quod denique ignotum pluribus Eruditis, per Annos aut Menses integros, in Actis quibusdam extraneis, facile deliteſcat; aut, si ad ipsos etiam perveniat, non ita paratos corripiat, ad propria studia deserenda, ut quam ocyssime ad sublimes, ac difficiles alienasque Meditationes deflectant. Quo etiam dato, etsi Calculus, ut sæpe fit, pro votis succedat, certe non omnes eadem, id in Publicum promulgandi, premuntur libidine. Sed id jam agemus, quod semel liceat invito, ut ostendamus rem Mathematicam non in tantis angustiis etiamnum versari, ut, ad ejusmodi Problemata, via uni tantum Mathematico, præter Auctorem, pateat. Quem tamen plurimum veneramur, atque summe laudatum volumus, ac præsertim ubi eximias Meditationes in publicum spargit, non evocatis quibus vel otium, vel studia non ab aliis obtrusa, magis arrideant. Sed ad rem.

Fig. I. Ab Altitudine, in qua constituta est Linea horizontalis LH, profectum Corpus grave eo devenit, continue accelerato a quiete motu, ut, per puncta proxima positione data A, B, jam jam transiturum sit. Quæritur Radius Arcus infinite parvi A G B, in quo describendo Corpus minimum temporis impendat.

Demittatur Horizonti perpendicularis L *a e*, occurrens Lineis A *a*, B *e*, Lineæ L H parallelis, in punctis *a* & *e*. Vertice L, Axe L *a e*, Parametro quovis *a*, describatur Parabola L P Q: Eruntque Corporis ab L H profecti velocitates, in quavis Altitudine A vel B, ut Ordinatæ in Parabola e regione positæ *a* P, *e* Q. Si jam intelligas Axem L *a e* in infinitas Lineolas æquales dividi, longe minores, atque etiam in infinitum minores, quam sit Linea *a e*, erit Tempus, quo quælibet ejusmodi Lineola describitur, reciproce ut Velocitas. Describatur Curva *d c n*, Lineis *a* P, *e* Q occurrens in *c* & *d*, in qua Ordinatæ *a c*, *e d* sint reciproce ut Velocitates *a* P, *e* Q. Ergo Lineæ *a c*, *e d* erunt ut Tempora, quibus Lineolæ æquales describuntur, Corpore versante in *a* & *e*. Et, cum hoc ubique obtineat, Tempus quo percurritur *a e*, erit ut Spatium *c a e d*.

A

A Punctis E & A erigantur, ad Figuræ Planum Perpendiculares, E D, A C, Lineis *e d*, *a c* æquales. Et a puncto G, in Arcu A G E medio, erigatur itidem G K A, correspondenti Ordinatæ *g l* æqualis: Ductaque, per Puncta D, A, C, Curva regulari D A C, erit Area D A C A G E D æqualis Tempori, quo Corpus describet Arcum A G E. Oportet autem Radium Arcus A G E ita determinari, ut Area illa sit quam minima.

Concipe Lineam D E, Lineæ A E parallelam & æqualem: Arcumque D K E, Arcui E G A itidem parallelum, aut si mavis supereminentem, & æqualem. Tum eundem Arcum D K E, adeoque totam Figuram D K E C A D, intellige in directum extendi; junctaque nova Linea D C, producatur K A ad O, Punctum in nova Linea D C medium.

Erit igitur Area D A C A G E D æqualis Arcui A E, ducto in Lineam E D; plus Arcui A E, ducto in $\frac{1}{2}$ B C; minus Arcu A E, ducto in $\frac{2}{3}$ A O. Quam Summam oportet fieri Minimo æqualem. Atque huc usque, protinus viso Problemate, Solutionem perduxi, de ulteriori Calculo, tunc temporis, non sollicitus. Sed jam Calculum ipsum, ab Amico rogati, absolvamus.

Ducatur *d b* ad *a c* perpendicularis: & a Puncto F, in Linea A E medio, ducatur ad H L parellela F V *u i m t*, occurrens Lineæ *a e*, in *u*, Curvæ *d c n*, in Puncto *m*; Subtensæ *d c*, in ejus Puncto medio *t*: Sintque G V, *l i* ad F *m* perpendiculares; & compleatur Rectangulum *l i t o*. Eritque *l o* æqualis A O; atque etiam æqualis *i m* plus *m t*.

Itaque Arcus A E, ductus in Lineam E D; plus Arcus A E, ductus in $\frac{1}{2}$ B C; minus Arcu A E, ducto in $\frac{2}{3}$ *m i*; minus Arcu A E, ducto in $\frac{2}{3}$ *m t*, æquantur Minimo.

Jam, ut superfluus Calculus vitetur, ex hac Summa primo tollenda sunt Producta, quæ data sunt. Deinde, ex Productis reliquis, ea rursus tollenda, quæ cæteris infinite minora sunt.

Sit

Sit Linea A F $= p$; ſitque Radius Arcus A G E $= a$: Hinc ſequitur Arcum infinite parvum A E æquari $2p + \frac{p^3}{3aa}$; eruto ſcilicet valore Arcus infinite parvi, ex ejus Sinu dato.

Igitur $2p \times$ E D $+ \frac{p^3}{3aa} \times$ E D; $+ 2p \times \frac{1}{2}$ E C $+ \frac{p^3}{3aa} \times \frac{1}{2}$ E C; $- 2p \times \frac{2}{3} mi$; $- \frac{p^3}{3aa} \times \frac{2}{3} mi$; $- 2p \times \frac{2}{3} mt - \frac{p^3}{3aa} \times \frac{2}{3} mt$, æquantur Minimo.

Jam vero data ſunt, ex hypotheſi, Producta Aſteriſco * notata; patetque proinde Inventione Lineolæ mt, ſeu Curvitatis Lineolæ cmd, opus non fore. Et, inter reliqua Producta, ea, quæ ſigno ‡ notata ſunt, cæteris, nempe primo inter ipſa, ſunt infinite minora.

Remanent itaque Termini, $\frac{p^3}{3aa} \times$ E D $- 2p \times \frac{2}{3} mi$, æquandi Minimo. Inter quos, ſi aliqui remanſiſſent, quos oportuiſſet deletos, nullus error tamen inde pertimeſcendus eſſet, cum iſta Terminorum Deletio, ad brevitatem duntaxat Calculi, comparata ſit: ita ut, ſi Termini remaneant, qui potuiſſent deleri, tandem ſuo loco inveniatur, ipſos illos Terminos delendos eſſe.

Itaque Denominationes Linearum E D, mi, jam inveniendæ ſunt.

Sit Abſciſſa L $e = x$; Fluxio $ea = \dot{x}$; Ordinata eQ erit $= \sqrt{ax}$. Ordinata ed vel E D ponatur $= \frac{aa}{\sqrt{4x}} = z$. Qua ultima Æquatione, per Methodum Fluxionum, tractata, invenietur Fluxionis bc Longitudo $= \dot{x}\sqrt{\frac{a^3}{4x^3}}$.

Linea F G æquatur $\frac{pp}{2a}$. Jam, quoniam data ſunt Poſitione Puncta A, E, ducta A R ad E Q perpendiculari, dabitur ratio Laterum A E, E R. Sit ea quæ p ad s.

Igitur fiat ut p ad s ſic F G, ſeu $\frac{pp}{2a}$ ad $\frac{sp}{2a}$; quæ Quantitas æquatur Lineæ G V, vel gu, vel li.

Rurſus ut db ad bc ita eſt li ad im; quæ proinde æquatur $\frac{sp}{2a}\sqrt{\frac{a^3}{4x^3}}$.

Ergo, ſubſtitutis valoribus ipſarum E D & mi, oportet $\frac{p^3}{3aa} \times \frac{aa}{\sqrt{4x}} - 2p \times \frac{sp}{3a}\sqrt{\frac{a^3}{4x^3}}$ æquari Minimo.

Itaque

Itaque & $\frac{2\dot{s}}{\dot{x}\sqrt{4x}} - \frac{2s}{x}\sqrt{\frac{x}{4x}}$ æquatur Minimo. Sit hoc $\frac{\beta}{\dot{x}\dot{u}} - \frac{\gamma}{\dot{u}}$. Erit igitur $-\frac{2\beta\dot{x}}{\dot{u}3} + \frac{\gamma\dot{x}}{\dot{x}\dot{u}} = 0$; id est $\gamma u = 2\beta$. Ergo $u = \frac{2\beta}{\gamma} = \frac{2pq}{\sqrt{4x}}$ applicato ad $2s\sqrt{\frac{x}{4x^3}} = \frac{2px}{s}$. Ut igitur s ad p, id est ut E R ad E A, ita est $2x$ ad x; quæ proinde æquatur 2 G H.

Itaque quantum Corpus grave, per Lineam Breviſſimi Deſcenſus cadens, a Linea horizontali L H, a qua cadendi initium fecit, remotum eſt; tantum præciſe Centrum Curvitatis Lineæ Breviſſimi Deſcenſus attollitur, ſupra eandem Horizontalem L H. Quæ notiſſima eſt Cycloïdis Proprietas. Hujus Vertex deorſum ſpectat; Baſis in ipſa L H conſtituta eſt; Circulus generans Baſin L H in H tangit, & tranſit per Punctum G. Vide Hugenii Horologium Oſcillatorium, Librumque in eo de Curvarum Evolutione. Atque ex his ipſiſſima fluit Conſtructio, quæ habetur in Tranſactionibus.

Si quis etiamnum eatenus imperfectam reputet noſtram Solutionem, quatenus ignorari poterat hanc fuiſſe Cycloïdis Proprietatem, ſciat facilem ab ea Regreſſum mihi, pluribus modis, ad alias notas Cycloïdis Proprietates, patuiſſe. Demonſtravi ſiquidem, in Curva noſtra, Fluxionem Ordinatæ, ad Baſin L H parallelæ, eſſe Summam Fluxionum Arcus, in Circulo dato, Baſin L H contingente, ejuſque Sinus; ſumpto Arcus initio vel a ſummo vel ab infimo Circuli Puncto. Quæ itidem trita eſt Cycloïdis Proprietas. Rurſus demonſtravi Curvam noſtram deſcribi motu Puncti, ſignati in Circumferentia dati Circuli, ſuper Baſin L H, more Rotæ, diſcurrentis; quæ primaria eſt Cycloïdis, apud Geometras, Generatio.

Calculum noſtrum aliquanto brevius inſtitui poſſe conſtat; neque tanta opus fuiſſe ἀκριβείᾳ. Sed cur aliis invideamus pleniorem, egregii Problematis, Tractationem, qua, minori cum moleſtia, ad eadem præſtanda, evadant promptiores. Nec enim, nullo Mathematici Lectoris commodo, ſcribere nobis propoſitum eſt.

Methodum, quam ſecuti ſumus, clarum eſt non eſſe Lineis L P Q, *n c d* propriam ; ſed locum etiam habere, ſuppoſita alia atque alia Gravitatis, ac Velocitatis cadentium Corporum, Lege.

Placet hic unam aut alteram Cycloïdis Proprietatem, a nobis repertam, addere. Anno 1690. occaſione horum Cl. Hugenii verborum, Horol. Oſcil. p. 11. *Quæ Proprietas inſignis neſcio an alii, præter Cycloïdem, Lineæ data ſit, ut ſe ipſam, ſui Evolutione, deſcribat* ; hocce Problema nobis directe ſolvendum propoſuimus ; Invenire Curvam, quæ ſe ipſam, ſui Evolutione, generet. Duplex autem eſt Problematis Caſus. Vel enim, Curvitatis Evolutæ Radio creſcente, decreſcit Radius Curvæ, ex Evolutione deſcriptæ ; & pariter, illo decreſcente, creſcit. Vel, Curvitatis Evolutæ Radio creſcente, creſcit & Radius Curvæ, ex Evolutione deſcriptæ ; pariterque, illo decreſcente, decreſcit. Priorem Caſum plene tunc ſolvimus ; talemque Lineam Solam eſſe Cycloïdem comperimus : quam Diſquiſitionem etiam cum ipſo Hugenio communicavi. Alterum Caſum non attigi ; cujus tamen Solutio, ſi augurari liceat, cum priori videatur eſſe facilior, inquirentem diu latere non poterit.

Intellige Corpus ſphæricum filo appenſum, cujus Centrum in Cycloïde, Penduli more, moveatur, cadendo ab altero Cycloïdis extremo, & ad alterum uſque extremum, Vibratione omnium maxima, procedendo. Movebitur Corpus illud, uniformi cum motu, circa Axem Horizonti parallelum : ac, toto hoc temporis ſpatio, dimidiam Rotationem, circa ipſum, conficiet. Fili autem Interſectio, cum horizontali Cycloïdis Baſi, motu æquabili, in hac Horizontali, uſque procedet. Sed eadem Interſectio, in Filo, ita movebitur, ut ejus Velocitas, a Centro penduli Corporis recedendo, vel ad ipſum accedendo, ſit ſemper proportionalis Sinui Complementi Anguli, quem Filum cum Horizonte conſtituit. Denique Fili Tenſio ex Vi Centrifuga, tum huic æqualis ubique Tenſio ex Gravitate, erit ut Fili ipſius Longitudo.

Lineæ

Lineæ Breviſſimi Deſcenſus Inveſtigatio Geometrica Poſterior.

POſitis quæ, in præcedenti Solutione, dicta ſunt, ducantur Rectæ A G, G E. Ergo, cum ſit F G $= \frac{pp}{2u}$, ſi, Centro A, Radio A F (p) deſcriptus intelligatur Circulus, invenietur A G minus A F æqualis $\frac{p^3}{8uu}$; ac proinde A G ſeu E G $= p + \frac{p^3}{8uu}$.

Jam ponatur Velocitas Corporis cadentis, in Altitudine A conſtituti, uniformiter perdurare, ad Altitudinem uſque G; ubi, ſubito Incremento adepto, iterum Velocitas Corporis cadentis, in Altitudine G conſtituti, uniformiter perduret, ad Punctum uſque E.

Moveatur autem Corpus cadens, non per Arcum A G E, ſed per Rectas, inter ſe æquales, A G, G E: Quæritur Punctum G, cujus talis ſit Poſitio, ut Tempus, per Rectas A G, G E, ſit omnium minimum.

Ergo $[p + \frac{p^3}{8uu}] \times ac$; $+[p + \frac{p^3}{8uu}] \times [um - mi]$ æquatur Minimo.

Sit L $a = x$; erit $ac = \frac{a\,a}{\sqrt{ax}}$. Sit au æqualis Fluxioni $\dot{x}$, & Æquatione $z = \frac{a\,a}{\sqrt{ax}}$ per Methodum Fluxionum tractata, prodibit $\frac{z}{2x}\dot{x} = -\dot{z}$: ac proinde, ducta mh ad ac perpendiculari, Fluxionis ch ſeu $-\dot{z}$ Longitudo erit $\frac{\dot{x}}{2x}\sqrt{\frac{a^3}{x}}$. Hinc ah ſeu $um = \frac{a\,a}{\sqrt{ax}} - \frac{\dot{x}}{2x}\sqrt{\frac{a^3}{x}}$.

Jam ut p ad s ita eſt F G $(\frac{pp}{2u})$ ad G V ſeu li; quæ proinde æquatur $\frac{ps}{2u}$.

Item ut $\dot{x}$ ad $-\dot{z}$ ita li ad im; id eſt ut $2x$ ad z ſeu $\frac{a\,a}{\sqrt{ax}}$ ita $\frac{ps}{2u}$ ad $\frac{aaps}{4ux\sqrt{ax}}$; quod æquatur ipſi im.

Itaque, ſubſtitutis ipſius ac, & $um - mi$, valoribus, erit $[p + \frac{p^3}{8uu}] \times \frac{a\,a}{\sqrt{ax}}$; $+[p + \frac{p^3}{8uu}] \times [\frac{a\,a}{\sqrt{ax}} - \frac{\dot{x}}{2x}\sqrt{\frac{a^3}{x}}; -\frac{aaps}{4ux\sqrt{ax}}]$ æquale Minimo.

Hac autem Æquatione, more communi, conſcripta, ſublatiſque Productis quibuſdam datis, iis videlicet, in quibus non occurrit incognita u, fit,

$\frac{p^3\,x\,a}{8uu\sqrt{ax}}; -\frac{aapps}{4ux\sqrt{ax}}; +\frac{aap^3}{8uu\sqrt{ax}} - \frac{p^3\,\dot{x}}{16uux}\sqrt{\frac{a^3}{x}} - \frac{a\,a\,p\,s}{32u\,x\sqrt{ax}} = M.$

Jactis Termino primo & tertio in eandem Summam, ductaque Æquatione in $\frac{4Vdx}{dppy}$, fit $\frac{p}{uu} - \frac{r}{ux} - \frac{pz}{4uux}$ $- \frac{ppr}{8u^3x} = M$.

Tollendo Terminum tertium quartumque, utpote cæteris infinite minores, & reliquos more Minimi tractando, fit

$- \frac{2pu}{u^3} + \frac{s}{uux} = 0$; unde prodit $u = \frac{2px}{s}$; quæ ipsissima est Solutio, quam priori Calculo, eoque elegantiori, inveneram.

Neque dubium moveas utrum Arcus circularis, ab A ad E ductus, cui describendo minimum Temporis impendatur, perpendicularem H F, in eodem Puncto G, secet, in quo concurrunt Rectæ æquales A G, G E, quæ minimo Tempore itidem describantur, inter innumeras ejusmodi Rectas. Quippe, propter parallelas ad sensum inter se Lineas omnes, in Arcu infinite parvo A G E, subtensas; si, quo Calculo usi sumus, ad inveniendas, loco ipsius A E, Rectas A G, G E, eodem utamur ad inveniendas, loco Subtensæ cujusvis alterius, verbi gratia A G, S T &c, Rectas novas A N, N G; S Z, Z T &c, & sic in infinitum; decrescentibus hac ratione continuo Subtensis omnibus, evadent illæ tandem in ipsissimum Arcum A G E.

Invenio inter Chartas meas, ante Annum unum vel alterum conscriptas, me ipsissimam Ideam habuisse, quam Cl. Jo. Bernoullius secutus est, in Inventione Curvæ Brevissimi Descensus, juxta Fermatii Doctrinam Refractionum. Calculum ipsum tamen non instituveram, quamvis facillimum. Sed ex illa Theoria videbam Tangentem Curvæ Brevissimi Descensus statim ubique dari. Quod ad Solutionem sufficere constat.

INVESTIGATIO GEOMETRICA SOLIDI ROTUNDI, IN QUOD MINIMA FIAT RESISTENTIA.

QUoniam noſtras, de Linea Breviſſimi Deſcenſus, Diſquiſitiones ſerius inſtituimus, Solidum etiam Rotundum, in quod minima oriatur Reſiſtentia, quamvis magis arduæ Diſquiſitionis, determinare placet. Certe nulla adhuc, me quidem conſcio, extat de illo Demonſtratio; nec a quoquam ſolutum intellexi hocce Problema, præter ipſum Newtonum. Cujus etiam Conſtructio talis eſt, ut, Solutionem quærenti, lucem nullam præferat. Fruſtra Cl. Hugenius iſtud Problema, Annis 1690 & 1691, me Hagæ Comitis tunc commorante, aggreſſus eſt.

Sit P T Axis Solidi Rotundi, quod a P verſus T moveri oporteat, minima proveniente Reſiſtentia. Sint A, E duo Puncta, in Solidi quæſiti Superficie, inter ſe proxima, ac in eodem cum Axe P T Plano poſita; quorum ſit E ab Axe remotius. Jungatur Linea E A, quæ producta Axem ſecet in T; atque Rectæ E A, ab ejus Puncto medio F, erigatur Perpendicularis G F P, Axi occurrens in P. Quæritur Poſitio Rectarum æqualium E G, G A, ex quarum Revolutione, circa Axem P T, orta Superficies minimam patiatur Reſiſtentiam. *Fig.* II.

* Centro

* *Fig.* III. * Centro C, Radio quocunque C D, ad P T parallelo, qui Resistentiæ perpendicularis Modus statuatur, describatur Circumferentiæ Circuli Quadrans D G X; eritque Recta C X ad C D perpendicularis. A Puncto † *Fig.* II. † E, ducatur, ad Axem P T Perpendicularis, E B. Sintque Anguli recti E B T, X C D, in utraque Figura, ad * *Fig.* III. eandem Plagam obversi. * Axe C D, Vertice D, Parametro C D, describatur Parabola D L Z N X. Sumpto in Quadrante D G X Puncto quolibet G, ductaque ipsi C D parallela G Z O, quæ Parabolæ occurrat in Z, Rectæ vero C X in O, erit Z O Modus, seu Mensura, Resistentiæ, ad illam Obliquitatem, quam præ se fert Quadrantis Circumferentia, in Puncto G. Sit jam Tan- † *Fig.* II. gens, in Puncto G, ad Rectam E A, † parallela.

* *Fig.* III. A Puncto G * capiantur utrinque, in Quadrante X D, æquales Arcus G A, G E, ea ratione, ut sint Anguli E G A, E G A, in ambabus Figuris, inter se æquales; & Puncta E, G, A; E, G, A simili ordine posita.

* *Fig.* III. * Arcuum E G, G A signentur media Puncta T, R; & ab his ducantur, ad C D Parallelæ, T N M, R L K; quarum illa Parabolæ & Rectæ C X occurrat, in Punctis N & M; hæc vero iisdem occurrat, in Punctis L & K. Erit itaque M N Mensura Resistentiæ, ad Obliquitatem ipsarum E G, E G; & K L Mensura Resistentiæ, ad Obliquitatem ipsarum G A, G A.

† *Fig.* II. † Sit A F vel F E $= p$. Radius Arcus A G E $= u$. Erit itaque F G $= \frac{p-f}{2-u}$. Ducatur ad Axem P T Perpendicularis A S. Et ad hanc ducantur Perpendiculares E R, G g, F u; voceturque ipsa F u, s; ipsa autem A u, t. Jam ut A F (p) ad F u (s) ita F G ($\frac{p-f}{2-u}$) ad $g u$, * *Fig.* III. quæ erit $\frac{p-f}{2-u}$. Denique sit A S æqualis x, C D vero * æqualis r.

Erit igitur $[\dot{x} + \frac{1}{2}t + \frac{p-f}{4-u}] \times [t + \frac{p-f}{2-u}] \times$ K L; $+ [x + \frac{1}{2}t + \frac{p-f}{4-u}] \times [t - \frac{p-f}{2-u}] \times$ M N $=$ Minimo.

Jam ut Radius u ad Radium r ita est p ad $\frac{p-f}{2-u}$; quæ æquatur ipsi A F, in Figura III.

Item

Item ut p ad s ita est r ad $\frac{r-s}{p}$; quæ æquatur ipsi C O, vel Z Y; Ductæ scilicet a Puncto Z, ad Angulos rectos, ad Lineam C D. Eritque proinde $YD = \frac{rss}{pp}$.

Per Punctum G ducatur Arcum E G A contingens Recta G I; sitque A I ad G I Perpendicularis. Denique sint R Q, T S ad G I Perpendiculares.

Ex his colligitur $AI = \frac{ppr}{2nn}$; & R Q sive $TS = \frac{p}{8}\frac{pr}{nn}$; & G Q sive $GS = \frac{pr}{2n}$.

Ducatur Q α ad C D parallela & G α ad Q α perpendicularis.

Ut igitur p ad t ita est G Q $(\frac{pr}{2n})$ ad G $\alpha = \frac{tr}{2n}$.

Sit R β ad Q α perpendicularis. Ergo ut p ad s ita est R Q $(\frac{ppr}{8nn})$ ad R $\beta = \frac{prs}{8nn}$.

Sit L γ ad C D perpendicularis. Erit $r - \frac{L\gamma q}{r} = KL$. Id est

$$r - \left[+\frac{r-s}{p} - \frac{tr}{2n} - \frac{prs}{8nn}\right]^2 \times \frac{1}{r} = KL.$$

Sit N δ ad C D perpendicularis. Erit $r - \frac{N\delta T}{r} = MN$. Id est

$$r - \left[+\frac{r-s}{p} + \frac{tr}{2n} - \frac{prs}{8nn}\right]^2 \times \frac{1}{r} = MN$$ Itaque erit

$$r - \frac{rss}{pp} + \frac{trs}{pn} - \frac{ttr}{4nn} + \frac{rss}{4nn} - \frac{prss}{8n^3} - \frac{pprss}{64n^4} = KL.$$

Sit hoc $= A - B + C - D + E - F - G$.

Item $r - \frac{rss}{pp} - \frac{trs}{pn} - \frac{ttr}{4nn} + \frac{rss}{4nn} + \frac{prss}{8n^3} - \frac{pprss}{64n^4} = MN$, quæ proinde $= A - B - C - D + E + F - G$.

Sed est $[tx + \frac{1}{2}tt + \frac{pss}{4n}; + \frac{psx}{2n} + \frac{pss}{4n} + \frac{ppss}{8nn}] \times KL$; $+ [tx + \frac{3}{2}tt + \frac{pss}{4n}; - \frac{psx}{2n} - \frac{3pss}{4n} - \frac{ppss}{8nn}] \times MN$ æquale Minimo.

Sit hoc $[\alpha + \beta * + \gamma + \delta + \varepsilon] \times KL$; $+ [\alpha + 3\beta * - \gamma - \delta - \varepsilon] \times MN = M$.

Ipsius autem δ valor est $\frac{pss}{2n}$.

Prodit itaque

$$\left[\begin{array}{l}
\alpha A - \alpha B + \alpha C - \alpha D + \alpha E - \alpha F - \alpha G \\
+\beta A - \beta B + \beta C - \beta D + \beta E - \beta F - \beta G \\
+\gamma A - \gamma B + \gamma C - \gamma D + \gamma E - \gamma F - \gamma G \\
+\delta A - \delta B + \delta C - \delta D + \delta E - \delta F - \delta G \\
+\varepsilon A - \varepsilon B + \varepsilon C - \varepsilon D + \varepsilon E - \varepsilon F - \varepsilon G.
\end{array}\right]$$

+

$$+\begin{bmatrix} \alpha A - \alpha B - \alpha C - \alpha D + \alpha E + \alpha F - \alpha G \\ +3\beta A - 3\beta B - 3\beta C - 3\beta D + 3\beta E + 3\beta F - 3\beta G \\ -\gamma A + \gamma B + \gamma C + \gamma D - \gamma E - \gamma F + \gamma G \\ -\delta A + \delta B + \delta C + \delta D - \delta E - \delta F + \delta G \\ -\varepsilon A + \varepsilon B + \varepsilon C + \varepsilon D - \varepsilon E - \varepsilon F + \varepsilon G \end{bmatrix} = M.$$

Id eſt

$$\begin{bmatrix} 2\alpha A - 2\alpha B - 2\alpha D + 2\alpha E - 2\alpha G \\ +4\beta A - 4\beta B - 2\beta C - 4\beta D + 4\beta E + 2\beta F - 4\beta G \\ + 2\gamma C - 2\gamma F \\ + 2\delta C - 2\delta F \\ + 2\varepsilon C - 2\varepsilon F \end{bmatrix}$$

$$= M = \begin{bmatrix} 2rtx - \frac{2trsx}{pp} - \frac{t3rx}{2uu} + \frac{trsx}{2uu} - \frac{pprsstx}{32u4} \\ +2ttr - \frac{2trrss}{pp} - \frac{t3rs}{pu} - \frac{t4c}{2uu} + \frac{rsstt}{2uu} + \frac{prst3}{8u3} - \frac{pprsstt}{32u4} \\ + \frac{trsx}{uu} - \frac{ppprsstx}{8u4} \\ + \frac{rsstt}{uu} - \frac{ppprsstt}{8u4} \\ + \frac{prs3r}{4u3} - \frac{p3rs3t}{32u3} \end{bmatrix}$$

Ex his octodecim Terminis, tollantur jam Termini cogniti, id eſt Termini, in quibus quantitas u non reperitur. Tales ſunt primus, ſecundus, ſextus, ſeptimus. Tollantur iterum, ex remanentibus Terminis, quicunque ſunt cæteris infinite minores. Tales ſunt quintus, nonus, decimus, undecimus, duodecimus, decimus quartus, decimus quintus, decimus ſextus, decimus ſeptimus, decimus octavus. Remanent itaque Termini tertius, quartus, octavus, atque decimus tertius. His autem per tr diviſis; prodit $-\frac{tss}{pu} - \frac{psx}{2uu} + \frac{3psx}{2uu} = M.$

Hinc erit $\frac{tssu}{puu} + \frac{ssxu}{u3} - \frac{3psxu}{u3} = 0$; ac proinde $u = \frac{3psx}{ss} - \frac{px}{s}$.

Talis itaque oritur Conſtructio, eaque ad Uſum Mechanicum accommodatiſſima. Occurrat * Recta EA Axi PT, ut dictum eſt, in T; ac conveniant Puncta EA in ipſo Puncto A. Sitque Angulus ATP 60 Gradibus minor. Sumatur SY æqualis 3ST; ſitque Punctum S, inter Puncta T & Y, poſitum. Itaque & Punctum P, in-

* *Fig.* IV.

inter Puncta S & Y, interjacebit. Et ducta Y Z ad P T perpendiculari, donec Lineæ A P occurrat in Z, erit P Z Radius Curvitatis in A. Quippe P A producta, donec ipsi T V, ad P T perpendiculari, occurrat in V, fit A V $= \frac{PSx}{ff}$; ac proinde A Z $= \frac{3PSx}{ff}$. Sed A P $= \frac{Px}{f}$. Itaque P Z $= \frac{3PSx}{ff} - \frac{Px}{f}$.

Alias sit S Y æqualis 3 S T. Sumatur S I $=$ P Y; sintque Puncta Y, I ad eandem partem Punctorum P, S; & a Puncto I ducta Linea I C ad P T perpendiculari, quæ occurrat ipsi A P in C, erit C Centrum Curvitatis in A, quandiu Punctum istud C ad concavam Curvæ partem positum est.

Si ad Praxin revocetur Curva nostra, sit † A E C Axis Solidi, A ejus Vertex; sit A D B ad Axem A C perpendicularis. Incipiatur Curva nostra D F G H describi, a quocunque volueris Puncto D, in perpendiculari A D B sumpto; dummodo extra Axem Solidi positum sit. Sitque, eo loco, Curvæ, ad Axem Solidi, Inclinatio Graduum 45. Itaque, descripta Curva D F G H, sit A E Solidi propositi Longitudo; E L, ipsi A E perpendicularis, ejusdem Solidi dimidia Latitudo. Ducatur Recta L F A, Curvæ D F G H occurrens in F; & fiat, ut A F ad A L sic A D ad D B. Curva nova B L, priori D F similis, a Puncto B incipiens, dabit Solidi quæsiti dimidiam Sectionem A B L E. *Fig.* V.

Si Curva D L Z N X, Figuræ III, non esset Parabola, sed alia quævis Curva, cujus Elementa dentur, ita ut Resistentia, in obliquam Superficiem, aliam quamcunque rationem habeat, ad Resistentiam perpendicularem, eodem modo procedet Solutio.

Reliquum erat ut Cl. Newtoni Solutionem, aliquanto perplexiorem, cum nostra, eaque simpliciori, conferremus, ut utramque veram esse pateret. Facto autem examine, inveni eandemmet nobis prodire Curvam. Sed nil mirum si Vir Summus, ac pluribus momenti majoris intentus, non sollicitus fuerit de reducenda, ad simpliciorem formam, Constructione, quam ejus Calculus ipsi suppeditaverat. In quo ipsum se-

quemur, nec ulteriorem ea, quam nacti ſumus, Simplicitatem ſectabimur.

Conſenſus itaque cum Newtono, pluribus, quam opus eſſet, Indiciis, patuit. Nam & Æquatio Newtoniana, & hujus Æquationis Fluxio, Terminis noſtris expreſſæ, veræ inveniuntur; & Curvæ Newtonianæ Radius idem prodit, cum Radio Curvæ noſtræ.

Quæret forſan Cl. Leibnitius, unde mihi cognitus ſit iſte Calculus, quo utor? Ejus equidem Fundamenta univerſa, ac pleraſque Regulas, proprio Marte, Anno 1687, circa Menſem Aprilem & ſequentes, aliiſque deinceps Annis, inveni; quo tempore neminem eo Calculi genere, præter me ipſum, uti putabam. Nec mihi minus cognitus foret, ſi nondum natus eſſet Leibnitius. Aliis itaque glorietur Diſcipulis, me certe non poteſt. Quod plus ſatis patebit, ſi olim Litteræ, quæ, inter Clariſſimum Hugenium meque, interceſſerunt, publici juris fiant. Newtonum tamen primum, ac pluribus Annis vetuſtiſſimum, hujus Calculi Inventorem, ipſa rerum evidentia coactus, agnoſco: a quo utrum quicquam mutuatus ſit Leibnitius, ſecundus ejus Inventor, malo eorum, quam meum, ſit Judicium, quibus viſæ fuerint Newtoni Litteræ, aliique ejuſdem Manuſcripti Codices. Neque modeſtioris Newtoni Silentium, aut prona Leibnitii Sedulitas, Inventionem hujus Calculi ſibi paſſim tribuentis, ullis imponet, qui ea pertractarint, quæ ipſe evolvi, Inſtrumenta.

Jam vero, ſi meas ipſius Meditationes, æquiori Lance, inter ſe comparandi, mihi concedatur facultas; ne vel mille ejuſmodi Problematum Solutiones, uni noſtræ Theoriæ Gravitatis, opponendas pronunciem. Quam equidem brevi publici juris facerem, quamvis chartulæ meæ, ante Annos novem conſcriptæ, jam non ſint ad manus, ſi mihi propoſitum eſſet ulterius recognoſcere, quo ſe jure SOLOS Mathematicos proclament Germani Geometræ. Certe Newtono, Summo Viro, primam Palmam, abſque omni diſputatione aut invidia, immenſo fere intervallo, præripiente; de ſecunda, in Phy-

Physicis ac Mathematicis rebus, plures, quam arbitrentur, invenient, neque forsan iniquis usqueadeo viribus, cum ipsis decertantes.

Agedum, quid jam de illa dicendum est Ordinis atque Existimationis, e Solio veluti Mathematico, singulis Geometris Distributione? Sed ignoscendum Viro, si minus de me aliisque, saltem de Mathematicis rebus optime merito. Aliis dico; qua enim æquitate, ut cæteros taceam, Lineæ Breviſſimi Descensus Inventio, subtilis quidem illa & egregia, opponatur eximiis illis Theorematis, usus prorsus infiniti, quæ Dnus *de Moyvre*, in Transactionibus Philosophicis, communicavit?

POSTQUAM hæc essent conscripta, brevis Otii Spatium nactus, determinare aggressus sum Curvæ * B L Descriptionem: Cujus quot volueris Puncta invenies, vel ex Tabulis Logarithmorum, invento scilicet ad Numerum datum Logarithmo; vel ex Hyperbolicæ Areæ Quadratura. Atque, ad inventa quælibet hujusmodi Puncta, dabitur tum Curvæ Tangens, tum Radius Curvaturæ. * *Fig.* V.

Sit A E Abscissa (x): E L ad A E perpendicularis Ordinata (y): B T Parallela ad Curvæ Tangentem in L: Punctum T Axis E A & Rectæ B T communis Intersectio. Sumatur A T (z) ad libitum; quæ tamen major sit quam A B: positaque A B æquali a, erit E L seu $y = \frac{4a}{4z} + \frac{1}{2}z + \frac{z^3}{4a4a}$. Invenietur autem E L facillime, si producta I K, ipsam B T ad Angulos rectos bisecante in I, donec ipsi B A occurrat in K, fiat ut A T ad B K sic B K ad E L: Quod eodem cum Constructione Newtoniana redit. Rursus erit $x = \frac{1}{4}zz + \frac{3z^4}{16} - u - q$.

Quantitas q data est, æqualis nempe $\frac{7}{16}a$. Itaque, posito a æquali 1, erit q æqualis 0,4375.

Quantitas u est Integralis Quantitas, orta ex Termino Analytico $\frac{z^3}{4a^3}$. Cognoscetur autem u, vel per Quadraturam Spatii Hyperbolici, vel per Inventionem Logarithmi ad Numerum datum z. Cum autem Logarith-

mi jam inventi sint, ad ejusmodi Numeros z, quos pro arbitrio eligere possimus, malumus Logarithmis uti, quam Hyperbola : præsertim dum in Arithmetica Tabula construenda versamur. Itaque ipsius $\frac{z^3}{4r}$ Integralem Quantitatem sic invenio. Intelligatur B M æqualis ipsi A B; sitque Angulus A B M rectus. Per Punctum M, Assymptoto B A, ducatur Logarithmica Linea M O; cujus Tangens in M secet Assymptotum A B, in Puncto, quod ab ipso B distet, intervallo æquali $\frac{1}{4}a$. Producta igitur B M, ut occurrat, in S, ipsi T O, ad Axem B A perpendiculari, erit S O æqualis u. Erit enim z ad u ut z ad $\frac{1}{4}a$. Ipsius autem u initium, in Linea B S, sumendum esse, nulla Quantitate data vel addita vel detracta, patet, ex Processu pleniori Demonstrationis, quem omitto. Cujus tamen, in gratiam Tyronum, addam Fundamentum.

Describatur Curva M V, talis naturæ, ut, ducta V Q ad A B perpendiculari, sit semper A Q $= y$; Q V $= z$. Ducatur M R, ipsi A B parallela : sitque Punctum R rectarum M R, Q V communis Intersectio. Hinc ostenditur facile esse y ad x, ut Rectangulum A Q R ad Aream Q B M V : quæ Area si per Methodum Fluxionum inquiratur, & dividatur per a, prodit ipsius x longitudo, qualis a nobis determinata est.

Posito quod Resistentia perpendicularis exprimatur per Aream ipsam, in quam fit Resistentia, ductam in Quantitatem a, vel ipsam Unitatem ; erit Resistentia in Basin orta, ubi Solidum movetur retrorsum, data cum Velocitate, $[\frac{1}{8}\frac{1}{zz} + \frac{1}{2} + \frac{3zz}{4} + \frac{z^4}{2} + \frac{z^6}{8}] \times \frac{c}{4r}$; positis scilicet r & c pro Circuli cujuscunque Radio & Circumferentia. Resistentia autem in anteriorem Partem, ubi Solidum movetur antrorsum, eadem cum Velocitate, erit ex Fluxionum Doctrina, $[u + \frac{1}{8}\frac{1}{zz} + \frac{5zz}{8} + \frac{3z^4}{16} + \frac{17}{16}] \times \frac{c}{4r}$.

Instituto itaque facili Calculo, Tabulam sequentem construximus ; cujus ope Curvam quæsitam & ipsi descripsimus accurate, in ampliori Charta ; & alii, quibus ita visum fuerit, describere poterunt.

AB

A B = I

A T = z	E L = y & A E = x		S O = u
1	1. 0.	y x	0.
2	3,125. 3,388213	y x	0,174287
3	8,333 333 16,725347	y x	0,274653
4	18,0625. 51,215927	y x	0,346573
5	33,8. 122,597641	y x	0,402359
6	57,041667 251,114560	y x	0,447940
7	89,285714 461,513523	y x	0,486477
8	132,03125. 683,042630	y x	0,519870
9	186,777778 1249,450694	y x	0,549306
10	255,025. 1898,986854	y x	0,575646
15	851,266667 9547,322987	y x	0,677013
20	2010,0125. 30098,812167	y x	0,749933
25	3918,76. 64312,195281	y x	0,804719
30	6765,008333 1,52098,712201	y x	0,850299
40	16020,00625. 4,80398,640281	y x	0,922219
50	31275,005. 11,72498,584495	y x	0,978005
60	54030,004167 24,30898,538914	y x	1,023586
70	85785,003571 45,03098,500377	y x	1,062123
80	128040,003125 76 81598,466984	y x	1,095516
90	1,82295,002778 123,03898,437548	y x	1,124952
100	2,50050,0025. 187,52498,411208	y x	1,151292
200	20,00100,00125. 3000 09998,236921	y x	1,325579
300	67,50150,000833 151187,72498,136555	y x	1,425945
500	312,50250,0005. 1 17188 12498,008849	y x	1,553651
1000	2500 00500,00025. 18,75002,49997,835562	y x	1,726938
1500	8437,50750,000167 94,92193,12497,734195	y x	1,828305
2000	20000,01000,000125 300,00009,99997,661275	y x	1,901225
3000	67500,01500,000083 1518,75022,49997,560959	y x	2,001591
5000	3,12500,02500,00005. 11718 75062,49997,433203	y x	2,129297
7000	8,57500,03500,000036 45018,75122,49997,349085	y x	2,213415
10000	25,00000,05000,000025. 187500,00249 99997,259916	y x	3,302584

Quam-

Quamvis autem ista Curva, quibusdam Erroribus, in Navium Constructione, vitandis, inservire possit; tamen aliam omnino Figuram adhiberi oportere mihi compertum est. Sed hæc ulterius prosequi non est Animus. Sufficiat dixisse multa adhuc Vulgo incognita remanere; quibus, si in apertum prodirent, ipsa Rei Nauticæ facies plurimum mutaretur, magno Regionum quarundam commodo, maximoque periculo aliarum; quas tamen salvas precamur.

HACTENUS fere cum Summis Mathematicis expostulatum est, coacto nobis invitoque prorsus Animo. Quippe quos libens tum honore summo prosequar, tum agnoscam, Newtono primas tenente, suo peculiari jure, cum paucis admodum Geometris, in primo ordine, ipsaque in fronte versari. Sed tamdiu me detinuerunt Typothetarum moræ, ut etiam Dnus S. Investigationis Lineæ Brevissimi Descensus, in publicum emittendæ, Spatium nactus, eandem fere mecum causam tractarit.

Vide Philos. Transact. N. 246.

At, infœliciſſimo eventu, summæ laudis æmulus Geometra difficillimum Problema præmature aggressus est. Quem utinam, utpote hoc tempore laudatis Viris nimium quantum imparem, res ipsa non requireret hic a me errorum suorum moneri. Quod libenti gratoque Animo acceptum feret, si secum reputet quanto cum felle, quantaque cum indignatione, potuisset ab aliis excipi. Nec enim patiuntur Geometræ suam contaminari Mathesin.

Duplex autem est errorum Ejus scaturigo. Primo quod supponat Tempus per Rectam AE *) esse Minimum, ac æquale Tempori per Arcum quæsitum AGE. Secundo quod ex hoc se Principio deducere credat Arcum AGE ad Cycloïdem pertinere. Nam neque Tempus per Rectam AE Minimum est; neque Arcus AGE, positis Temporibus per Rectam AE & Arcum AGE

Fig. I.

æqua-

æqualibus, in Cycloïde noſtra conſtitutus eſt, ſed totus extra illam cadit: ejuſque Centrum in ipſa Horizontali L H poſitum eſt. Unde oporteret Dnum S. arguiſſe, Lineam Breviſſimi Deſcenſus eſſe, non Cycloïdem, ſed Semi-Circulum.

Fateor equidem, neglectis ſecundis Fluxionibus, quæ nullatenus erant negligendæ, Tempora per Rectam A E, & per Arcum quemcunque A G E, eſſe æqualia; ſi Arcus ille deſcriptus ſit Radio non infinite parvo. Sed hoc neminem ad Cycloïdem, potius quam ad infinitas alias Curvas, deduxerit. Imo ipſum Problema Bernoullianum eo redit, ut inveniatur quis demum, inter infinitos Arcus, per Puncta A & E ductos (eoſque, ſi ſecundas Fluxiones neglexeris, omnes inter ſe æquales) minimo deſcribatur Temporis Spatio.

Transferantur Puncta A, F, E, G in Sextam Figuram; & producatur F G in N: ductaque a Puncto G Linea G I, ad F G perpendiculari; quæ G I exprimat Tempus per A G E; exprimant eadem ratione Ordinatæ F K, N L, ad G I parallelæ, Tempora per A F E, & Arcum A N E. Denique moto Puncto N, per Lineam F G, deſcribat Ordinatæ N L Punctum extremum L Curvam L I K. In illa Curva erit G I minima, ubi Punctum G in Cycloïdem noſtram incidit. Hinc Puncta K, L, recedent utrinque paulatim a Recta F N; &, poſita K L ad F N parallela & æquali, Tempus per cognatum Arcum A N E æquabitur Tempori per Rectam A E. Quantum autem iſte Arcus A N E differat ab Arcu Cycloïdali A G E, vel Tyro videat, Si tamen Dnus S. mitiori Animadverſione non contentus, pleniorem mereri ſuſtinuerit, demonſtrabimus, vel pro nobis alii, non tam ipſi, qui noſtra forſan nondum capiet, quam Orbi Mathematico, quis ſit Arcus ille A N E, qui eodem Tempore cum Recta A E deſcribatur, quantaque ab Arcu Cycloïdis A G E differentia diſtet. Sunt ſcilicet Lineæ F G, G N inter ſe æquales. Quod equidem ita eſſe tum nullus ambigebam; tum etiam, inſtituta accuratiori Arcus A N E Inveſtigatione, demonſtravi. Ex

Fig. VI.

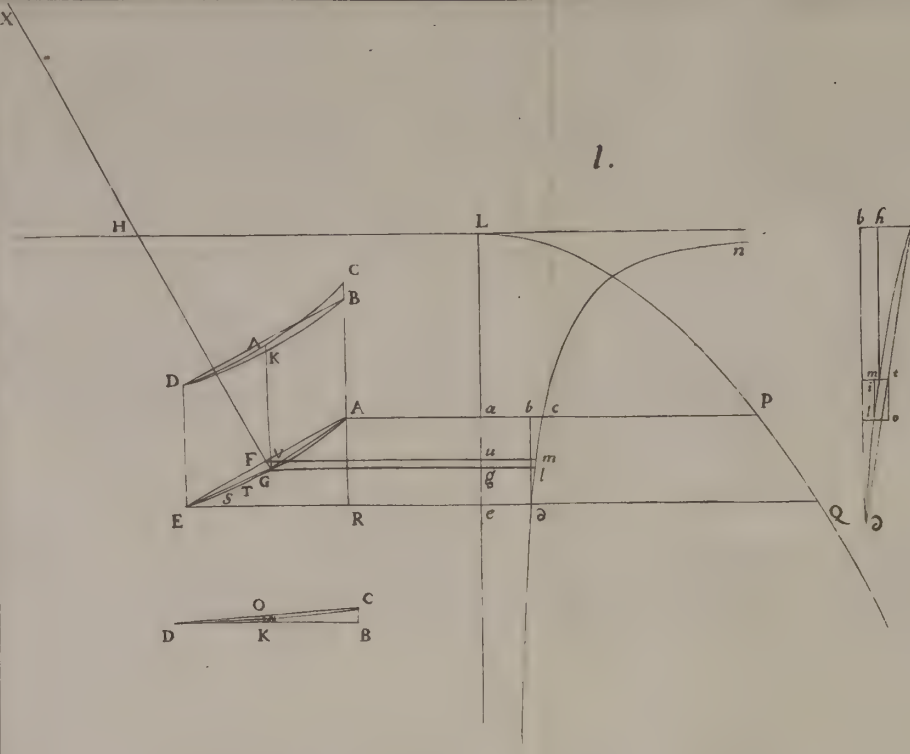
Ex præmiſſis manifeſtum eſt Dnum S. ſi per devia prorſus & abrupta loca non excurriſſet, Demonſtrationis tamen, non vero Inveſtigationis, Titulum Scripto ſuo apponere debuiſſe. At vero, ut jam ſe res habet, neutram Vocem uſurpaſſe ipſi licitum eſt. Laudandus tamen eſt Animi, ad ardua ſemet efferre adlaborantis, conatus. Quem olim fœlicior fortaſſis eventus, præſertim in Diſquiſitionibus minus perplexis, excipiet.

FINIS.

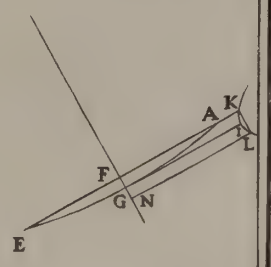
CORRIGENDA.

PAG. 8. l. 9. *Verba* [patetque proinde Inventione Lineolæ *m t*, ſeu Curvitatis Lineolæ *c m d* opus non fore] *transferantur ad finem Paragraphi.* p. 10. l. 29. hoc. p. 12. l. 28. inſtitueram totum, quamvis.

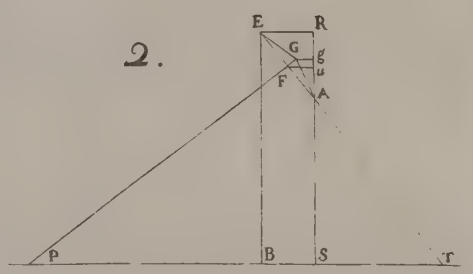
1.



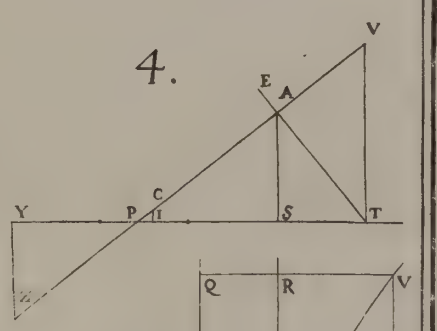
6.

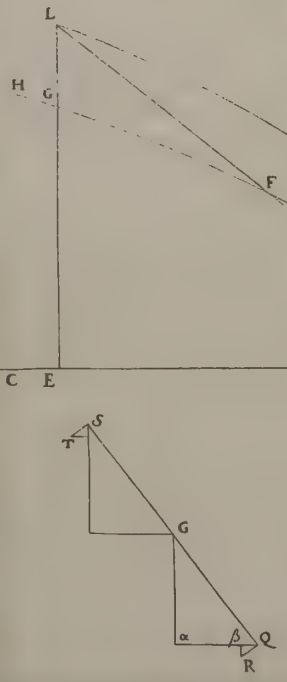


2.

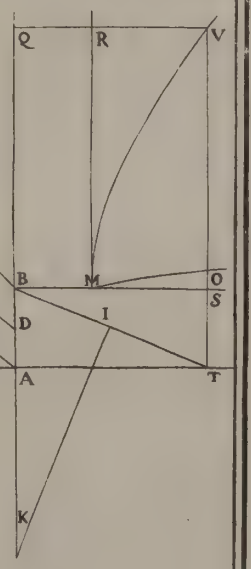


4.

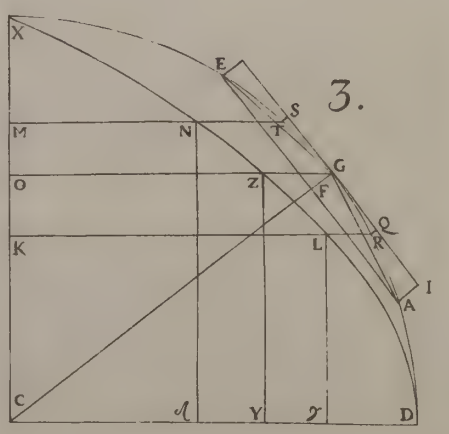




5.



3.



S.G. Sculp.